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COORDINATING FLUID MILK SUPPLIES IN THE OKLAHOMA METROPOLITAN MILK MARKET

MARKETING RESEARCH REPORT NO. 686 U. S. DEPARTMENT OF AGRICULTURE
MARKETING ECONOMICS DIVISION ECONOMIC RESEARCH SERVICE

CONTENTS

Page

Summary and implications . . . iii
Introduction . . . 1
Objectives . . . 1
Description of market . . . 1
Methodology . . . 2
  General problems in supply management . . . 3
  Time flexibility . . . 4
Fluctuating producer receipts . . . 7
  Seasonal producer receipts . . . 7
  Daily receipts by handlers . . . 7
  Weekly producer receipts . . . 9
Fluctuating demand . . . 16
  Seasonal demand . . . 16
  Weekly demand . . . 18
  Daily demand . . . 18
Contribution to surplus . . . 23
  Seasonal surplus . . . 23
  Source of weekly surplus . . . 27
Coordinating supply with demand . . . 27
  Seasonal comparisons . . . 27
  Weekly supply-demand balance . . . 29
  Fluctuations for individual plants and groups of plants . . . 33
  Actual receipts vs. scheduled receipts . . . 33
  Extra supplies as a balancing device . . . 36
  Diverting milk to attain a more desirable balance . . . 37
  Coordinating intercity shipments . . . 39
Role of the manufacturing plant . . . 40
  Central compared with individual processing of excess milk . . . 41
  Comparative costs of handling excess milk . . . 43
Conclusions . . . 50
  Potential economies from supply coordination . . . 51
  The individual handler and central supply coordination . . . 54
  Competition and fluctuations . . . 55

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SUMMARY AND IMPLICATIONS

Changing relationships between marketing firms have accompanied such changes in the technology of processing and handling milk. Many of these changes have involved such a substantial capital outlay for new equipment that economies of scale have become increasingly significant. Because supply and demand both fluctuate rather violently, and often in opposite directions, milk handlers have found it necessary to provide a relatively high degree of flexibility at considerable cost.

These and other competitive factors force firms and markets to be cost conscious and to initiate arrangements and practices which lead to improved efficiency.

The high cost of procuring and coordinating a fluctuating supply with variable demand, and the possibility of eliminating some of the uncertainty in this area, has led many handlers to adopt full supply arrangements with a central supply agency. Such an arrangement does not eliminate fluctuations, but it does reduce their severity as compared with individualized responsibility and provides a relatively simple, routine means of adjusting supply to demand with minimum effort and expense. The decreased burden of uncertainty is thus borne by a single agency which is in the best position to make the necessary adjustments.

In the Oklahoma Metropolitan Milk Market, there has been an increasing tendency to consider the related functions of farm quality control, procurement, assembly, and surplus management as the responsibility of the producers' cooperative. Varying degrees of centralization of these responsibilities appear to be associated with differences in cost of rendering the services. In general, centralized supply management decreases both the actual handling cost and the reserve required to meet market needs.

Central facilities to process the excess milk from six representative Oklahoma handlers could be operated at less than one-half the cost of operating individual facilities. Expanding this comparison to all handlers in the market gives an annual cost difference of about $400,000 for processing excess milk into manufactured products.

Intercity transfer costs in Oklahoma could be reduced readily by at least 15 percent through central supply coordination. Savings could also be realized in farm collection, although this function is not analyzed in this report. The actual cost of executing the supply coordination and assembly functions varies between markets. The relative cost also varies, but the comparisons described in this analysis may be applied to most milk markets in comparing alternative systems for specific conditions.

Uncertainty in supply management includes both volume and timing. Potential gains in efficiency result from minimizing the degree of this variablity and uncertainty, thereby decreasing the cost of providing adequate flexiblity. Provision of more flexibility requires greater physical facilities, labor, and reserve supplies of milk.

Individual plant supply management would require a greater reserve supply than central supply management. Daily producer receipts of seven individual plants were between 85-120 percent of the average about 70 percent of the time, while these same seven plants as a group were within this range 98 percent of the time.

The seven combined were in this range each week, while as individual plants they were outside the range 12 percent of the weekly periods. Reserves to meet weekly fluctuations in producer receipts could be 56 percent smaller for the seven as a group than reserves needed to supply each plant individually.

Combined fluid sales of three plants showed a 39-percent reduction in weekly volume fluctuation compared with sales of the same three as individual plants. The reduction was 28 percent on a daily basis.

The amount of reserve milk needed to properly supply the market can best be expressed in terms of producer receipts as a percent of fluid use. This measure considers fluctuations on both the supply and demand side. Three plants required 21 percent more reserve milk to meet these weekly fluctuations as individuals than when combined. Weekly producer receipts were 105-149 percent of fluid sales 90 percent of the time for the three plants combined, but only 70 percent of the time as individual plants.

A major source of the improved efficiency resulting from centralized management of milk supplies is external to the individual firm. Even an efficient firm that continued to exercise full responsibility for its supply when the rest of the market changed to a central management system would soon become the disadvantaged member in the market.

Central management of milk supplies provides a vehicle for orderly market development and introduction of new technology. Alternatives available at a given stage of development depend directly upon decisions made during previous stages. A high degree of interdependence exists among market participants. Decisions by specific firms limit the potential alternatives available to others.

Competition among handlers is not eliminated, nor even decreased, with the introduction of rational supply coordination. The form of the competition is altered and the emphasis shifted to other competitive policies. One form of lessened competition is that between milk producers themselves.

Potential gains in efficiency resulting from central supply coordination are not unique to any portion of the market, but are distributed among the various functions. Firms and markets with efficient procurement and assembly systems would realize relatively smaller gains from centralization than those with inefficient systems. The overall market system would experience absolute and relative gains, but specific firms and markets would lose this relative advantage over other participants. The marginal product differs for the individual firms and for the market as a whole.

Providing flexibility through a gradual transition to a new technology or method (e.g., can to bulk handling) proves more inefficient and costly than either the old or the new method. Efficiency is lost in dual systems when both have insufficient volume to permit reasonable economies of scale.

Few fluid handlers procure adequate milk from regular producers to meet all their needs all the time. Although the degrees of variation and uncertainty are reduced decidedly with central supply coordination, still it may not prove desirable to meet all needs from milk of regular producers 100 percent of the time. The desirable level of satisfaction by regualr producers depends upon the relative costs of securing supplementary supplies as compared with profitable utilization of surplus milk. Institutional factors must be considered also.

COORDINATING FLUID MILK SUPPLIES IN THE OKLAHOMA METROPOLITAN MILK MARKET

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INTRODUCTION

Market participants constantly adapt their activities so as to perform their functions in a more acceptable manner. This adaptation is a form of evolution. The policies and practices which permit success are continued; the less successful are discarded.

Flexibility of operation is essential in an industry where change, a high degree of fluctuation and perishability of product are facts of life. Success in handling supplies of milk depends largely upon management's providing an adequate degree of flexibility without excessive capacity and associated costs.

Apparently milk production is becoming less seasonal, but deliveries to individual plants are becoming more variable from day to day. Demand for bottled milk has become especially heavy on weekends for sale through retail stores. Demand for milk and milk products also exhibits a sesonal pattern, so that both supply and demand vary seasonally and from day to day. Part of these fluctuations follow a predictable pattern; part do not.

OBJECTIVES

This study seeks to determine and evaluate the relative efficiency of different methods for managing the total milk supply for fluid markets. The degree of efficiency is measured in two general ways: (1) The portion of the milk supply which must be carried as necessary reserves, and (2) the relative cost of managing and handling the flow of milk by different methods.

An appraisal of systems of managing milk should help firms take advantage of new opportunities without undue delay and to realize the advantages of cost reduction and new technology without unnecessary expenditures. Inability of, or hesitancy by, a market system to properly adjust usually means economic loss due to perpetuation of inefficiencies and to greater capital outlays than are justified.

The main objectives of research in the supply coordination area are: (1) To determine and evaluate the relative efficiency of different methods of managing the total milk supply for a market, (2) to describe the evolutionary process whereby specific markets have attained their present status, (3) to develop a course of action by which specific markets may achieve improvements in coordinating the milk supply, and (4) to generalize from the specific case studies so as to provide helpful information to other markets.

DESCRIPTION OF MARKET

The Oklahoma Metropolitan Milk Market covers the metropolitan areas of the northeastern two-thirds of Oklahoma. This Federal Order Market was established

April 1, 1957, by combining the Oklahoma City and Tulsa-Muskogee orders. The Oklahoma City Order had been in effect since April 1, 1950. Tulsa-Muskogee, established on August 1, 1953, combined the Tulsa Order, established April 1, 1950, with the small Muskogee Order, established July 1, 1951.

All 20 plants of regular handlers operating in the market were considered in various comparisons. Twelve manufacturing milk plants provided outlets for milk not utilized in the plants of regular handlers. Three producer cooperatives served the area, with some overlap of service areas.

The market displayed a variety of situations concerning management of the milk supply. One cooperative was primarily an operating plant, one was a bargaining association, and one was a combination of these two. The latter two completed facilities for processing surplus milk after this study was made. Some handlers were responsible for their own milk procurement and assembly; others depended upon the producers' cooperative to supply them with milk as needed. A few handlers fell between these two extremes.

Most handlers processed their own fluid milk, cottage cheese, and ice cream. Some also processed limited quantities of surplus milk into sweet cream, frozen cream, butter, condensed milk, or non-fat dry powder. The bulk of the manufacturing, other than cottage cheese and ice cream, was by separate manufacturing plants. These plants had a base supply of manufacturing grade milk from regular producers, but were dependent upon the volume of surplus Grade A.

The primary milkshed for the Tulsa area is more or less separated from the western portion of the milkshed by a 30-mile-wide zone of very low milk production. This zone helps hold down the procurement overlap. There is extensive sales competition thoughout the market area.

METHODOLOGY

The case study approach has been utilized in comparing the various coordinating systems. This initial report is based upon a study of the Oklahoma Metropolitan Milk Market, representing a fairly decentralized coordinating responsibility.

Data for 1962 were obtained from records and personal interviews with personnel representing individual handlers, producer cooperatives, manufacturers, market administrators, health regulatory agencies, the Oklahoma Department of Agriculture, dairy and marketing specialists at Oklahoma State University, and specialists in adjacent market areas.

The plants represented in various computations are not consistent throughout the report. Complete data were not available in many cases and some data were not comparable. The tabulations and comparisons are based upon comparable data.

Costs, efficiency, reserves, and other measures are considered in a relative sense rather than as absolute measures. This permits application to more diverse market conditions. This report does not emphasize statistical tests of significance; rather, the differences are used to illustrate and compare alternatives as plants and groups of plants are compared in several ways to show the problems involved in coordinating the supply of milk and to suggest solutions.

The existing competitive model as influenced by producers, outlets, product mix, prices, govermental programs, regulations, quantity, and quality was accepted as predetermined.

Responsibility for coordinating the flow of milk may be exercised by the individual plant, by a small group of plants, by a broker, by a producers' cooperative or federation of cooperatives, or by a combination of these. The coordination might be for a single plant or for the entire market. The level and extent of responsibility is considered to be the relevant variable in this study as the implications of varying the centralization of this responsibility are considered.

General Problems in Supply Management

Traditionally milk marketing firms have accepted the dual responsibility of providing an outlet for all the qualified milk their farmer patrons supply and of providing all the milk their customers desire to purchase. Performing these two functions is made more difficult by fluctuations on both sides.

A firm with its own procurement, assembly, processing, and distributing systems has certain alternative means of adjusting operations in response to fluctuating demand and supplies. The actions taken will depend largely upon the frequency and severity of the fluctuations, the division of fluid sales between retail and wholesale, whether the firm operates manufacturing facilities, the ease of disposing of surplus, the volume of milk handled in each phase of the business, the procurement area, the availability of supplementary supplies, and regulations influencing the market.

To assure supplies adequate to meet varying needs, most plants have found it necessary to carry considerable reserve supply. This is especially true when supplementary supplies are not readily available. Generally, each plant tends to build a procurement system such that supplies are just adequate when supply is relatively short compared to demand. The rest of the year, the firm will expect to have milk supplies greater than the local demand. But regardless of the volume handled, managers need to consider the probability of fluctuation of varying degrees in supply and demand.

Despite the fact that certain conditions occur in a sort of pattern--that a given response may be expected three times out of four and be statistically significant--in supply coordination the exception is of more consequence than the normal situation. Management actually functions in the extreme or deviate conditions; normal flow presents a preponderence of routine problems.

Under conditions of uncertainty, a market system must provide the flexibility necessary to balance supply with demand effectively. The greater the uncertainty, the greater the flexibility necessary. Providing this operating flexibility is costly. Marketing costs can be reduced by decreasing uncertainties.

Figure 1 shows two hypothetical unit cost curves for processing milk. The solid line illustrates a curve appropriate for a plant designed for a constant level of input-output. While this plant can produce very efficiently at its optimum level, it would be in difficulty if a volume change were necessary.

The dashed line represents the cost curve for a plant designed to provide operating flexibility. Such a plant can never quite approach the extreme efficiency of the first plant, but neither does departure from optimum lead to such severe cost penalties.

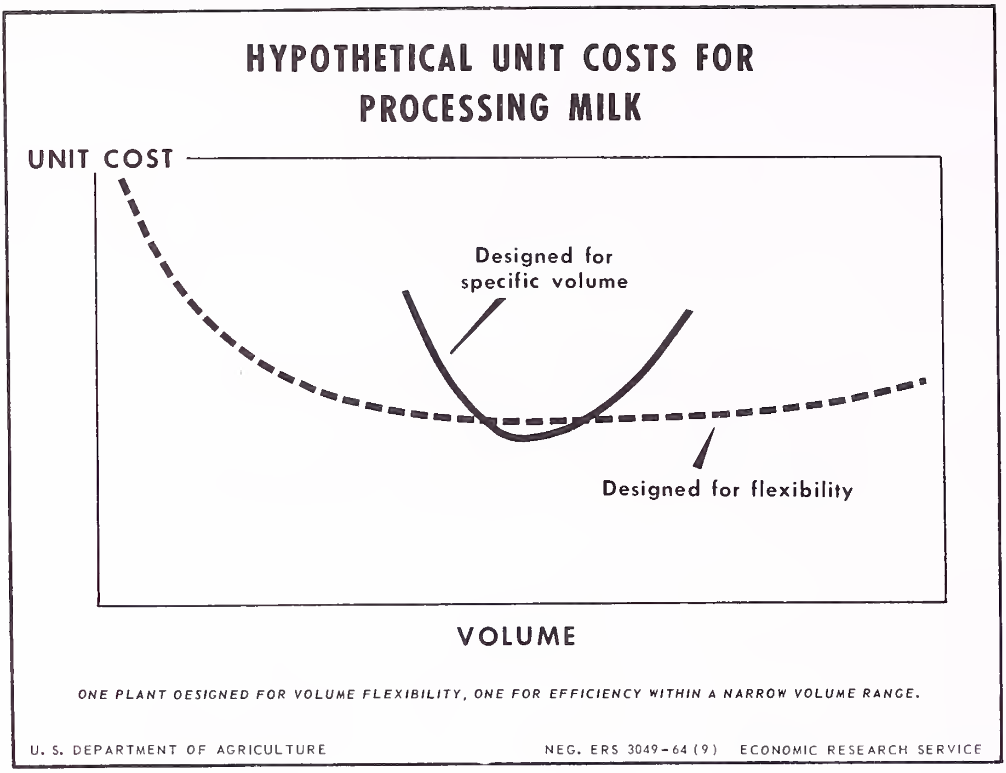


Figure 1

The greater the degree of fluctuation which must be borne, the greater becomes the pressure for a system such as that represented by the dashed line.

In a market with several competing firms, those with more uniform operations may realize a significant competitive advantage. As the number and intensity of uncertainties facing a firm are reduced, it can more nearly approach the efficiency represented by the solid line.

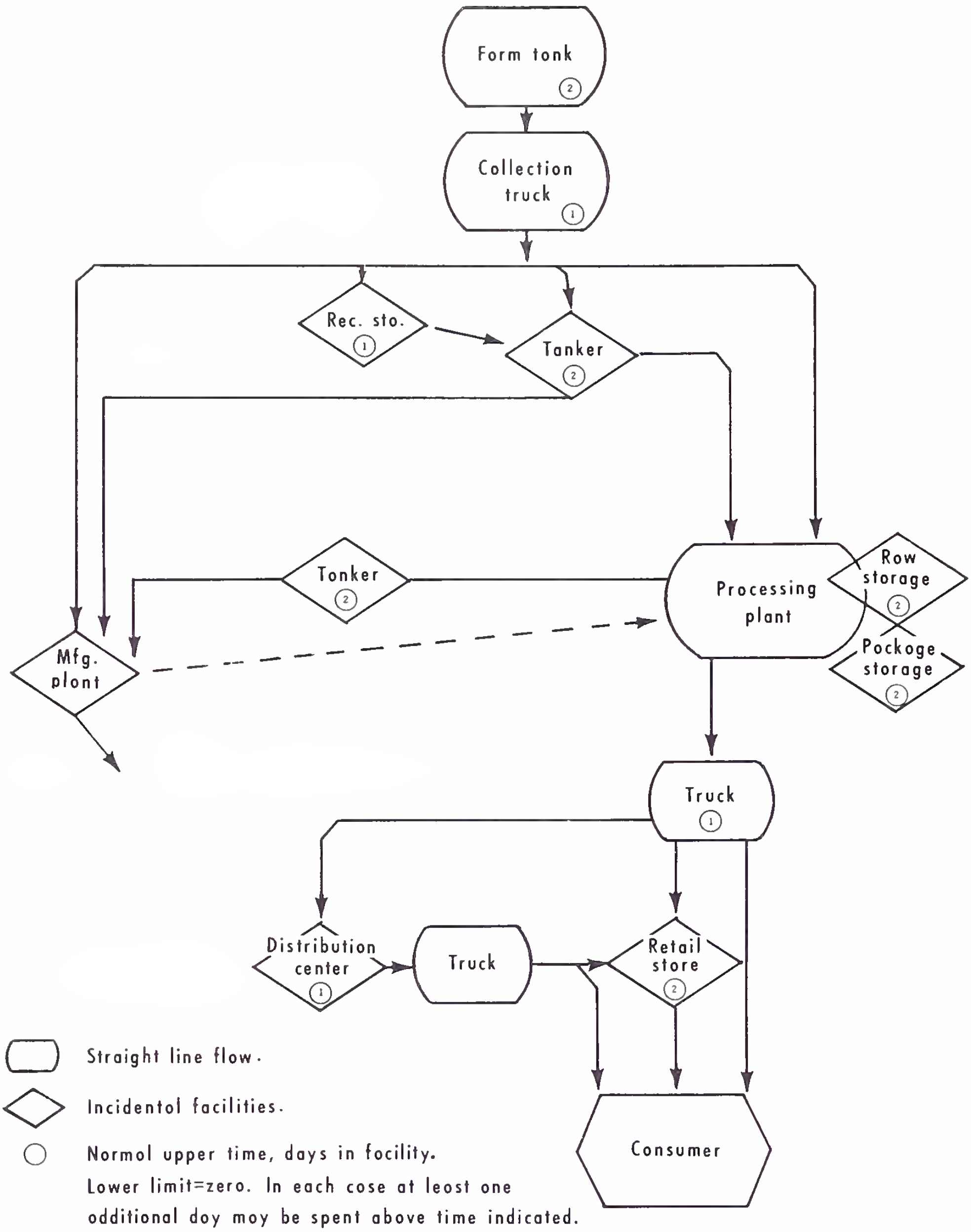
This report compares the degree and frequency of fluctuation and uncertainty which individual plants and various groupings of plants would have encountered under different systems of supply coordination. The alternatives for coping with these situations are compared for these different groupings.

Time Flexibility

Several opportunities for manipulating the milk flow so as to provide time flexibility are found in the assembly-processing-distributing complex. Timeliness may be achieved by speeding or delaying the flow of milk through the system. The several phases may be coordinated or each may function as an entity, although directly dependent upon complementary functions. A variance of a week may be accomplished readily with fluid milk by manipulating the velocity of the several functions.

High quality--lower bacterical counts and lower temperature--increases the length of time milk may be held in each phase of the marketing process. The diagramatic outline in figure 2 shows the flow of milk, with the points for flexibility in time indicated.

OPPORTUNITIES FOR MANIPULATING MILK FLOW TO GAIN TIME FLEXIBILITY



Straight line flow.

Incidental facilities.

○ Normal upper time, days in facility. Lower limit=zero. In each case at least one additional day may be spent above time indicated. Times are not cumulative.

NORMAL TOTAL TIME IN SYSTEM IS 4 TO 6 DAYS. THIS MAY BE READILY ALTERED PLUS OR MINUS 2 DAYS AND MAY TEMPORARILY BE LENGTHENED TO 10 TO 12 DAYS.

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Figure 2

Bulk cooling on the farm offers the first possibility for varying the velocity. Milk is regularly collected every other day from the bulk tanks. In emergencies, the period could be lengthened or milk could be collected after each milking for short periods.

The collection truck offers a second opportunity for temporary storage. The milk may be unloaded immediately upon arrival or held up to 2 days. Milk may be unloaded from the collection truck directly at the processing plant or may be reloaded into another tank truck. A reload station may store milk for 1 or 2 days. Shipped in an over-the-road tanker, the milk may be on the road or held on a plant lot for 2 days. Extra tankers would be needed to obtain this type of flexibility. Alternatives should be weighed in order to operate most efficiently.

Manufacturing plants receive raw milk from a variety of sources and at equally varied stages of the flow pattern. Milk may be processed into consumer products or intermediate products used by fluid and other plants to produce a variety of goods. The intermediate products may be storable or highly perishable. Examples include skim milk, sweet cream, condensed skim, powder, and butter. Those who freeze ice cream utilize these products rather liberally. The use of storable products permits processing plants, indeed each segment of the industry, to operate at a more uniform level with smaller reserves of milk than would otherwise be possible. Although the manufacturing operation is shown as a single step in figure 2, intermediate steps may occur.

Manufacturing plants experience extreme variability due to the nature of their receipts. To combat the day-to-day fluctuation, they may store raw milk up to 3 days or vary product mix. When supplies become overly abundant, less profitable products absorb more of the milk. Both in periods of relative abundance and of shortage, milk and even intermediate products are temporarily stored in order to take advantage of the most profitable outlets.

Processing plants may vary their operations from working directly from the unloading tank truck to storing raw milk for a 2-day period. Packaged milk may be moved by conveyor line directly from the packaging unit into a truck, or it may be stored over the weekend. When loaded directly into a truck, the packaged milk may be delivered immediately to the consumer or to a distributing point, or it may be stored temporarily.

Distribution centers are chiefly reloading points from large van trucks to route delivery trucks, but they may serve as overnight storage facilities as well.

Retail stores prefer daily service by the routeman. However, delivery 3 times per week is common, especially to smaller stores. Large supermarkets may be serviced several times a day, especially on Friday and Saturday. Vertically integrated processor-retail outlets appear to possess an advantage in storage, in that the buildup in store inventory for weekend sales may be started by the bottler earlier than in completely independent stores. Store time may easily vary from selling directly off the truck to twice-a-week delivery.

Consumers have several alternatives for obtaining their "daily" milk. Retail route deliveries are now normally made 3 times per week. Consumers have been shifting from home delivery to retail store purchase of milk. Many tend to purchase an entire week's supply at one time. The heavy shopping days are Friday and Saturday, with light mid-week purchases.

The diagram is not all inclusive, but it illustrates the opportunities for adjusting flow velocity in marketing fluid milk and associated products. The time periods indicated for the various points or intersections are normal time lapses. The total length of time from farm to consumer may not be found by summing the individual time lapses indicated. The flow through these stages in the market channels normally requires from 4 to 6 days. This may easily be varied 2 full days in either direction. When timeliness is urgent, this flow may be hastened to a matter of hours or stretched out to 10 or 12 days.

FLUCTUATING PRODUCER RECEIPTS

Systems of supply coordination are compared by measuring the fluctuations in receipts and utilization of different groupings of plants. Production fluctuations are expressed in terms of actual pounds, as a percent of a "normal" situation, or compared directly with the demand or utilization pattern. Producer receipts are subject to three types of variation: (1) Long-time or cyclical, (2) seasonal, and (3) random short-time changes.

Milk production in Oklahoma declined significantly from 1940 to 1960. During this time, both milk production and milk cow numbers declined relatively more in Oklahoma than in any other State. In 1960 the number of milk cows in Oklahoma was only 36 percent of the 1940 number, and Oklahoma produced only 60 percent as much milk.

Grade A milk production increased in the Oklahoma Metropolitan milkshed each year following the introduction of the Federal order in 1957. Average daily deliveries per producer increased more than 50 percent from 1957 to 1962, reflecting an increase in deliveries per farm and also a greater than proportional decrease in the relatively small producers on the market. Producer receipts for the market were 1,180,736 pounds per day in January 1958 and 1,543,353 pounds in January 1962. Class I use of these receipts increased from 1,000,451 pounds per day to 1,185,451 pounds during this same period. Analysis of these long-term changes is not a part of this study.

Seasonal Producer Receipts

Seasonal variation in milk production on farms has decreased in most fluid milk markets. Pricing policies designed to reward producers for more uniform production have achieved some success. Larger and more specialized dairy farms, with high fixed costs, have also contributed to a less volatile seasonal production pattern.

Table 1 shows the seasonal pattern for the major handlers and groups of handlers in the market as a percentage of the average for the year. Only 7 of the 20 handlers had maximum average daily receipts occurring in a month other than May. Five of these plants are shown; both the others were very small units, reaching the peak in June.

The timing and general extent of seasonal changes in milk production may be predicted rather accurately. This permits handlers to ready their facilities for the anticipated change.

Daily Receipts by Handlers

Daily producer receipts vary because of fluctuating production and differences in the collection of milk by bulk truck. The latter is especially marked for smaller plants, because of the difficulty of balancing every-other-day receipts while maintaining a full load of milk each trip. Larger plants have an advantage in this respect, which is even more pronounced for multi-plant operations and cooperatives servicing several plants.

Table 1.--Producer receipts by specific plants in Oklahoma Metropolitan Milk Market: Daily average by month as a percent of yearly average, 1962

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Plant A.............	90	92	95	106	112	105	109	103	98	97	96	97
Plant B.............	92	101	104	106	113	110	107	101	97	94	89	87
Plant C.............	96	99	102	104	104	104	107	96	99	96	95	97
Plant D.............	91	104	109	113	126	109	100	87	88	80	99	95
Plant E.............	97	100	108	98	112	106	104	108	96	99	82	90
Plant F.............	97	105	105	108	117	124	108	95	93	83	84	82
Plant G.............	94	96	98	112	122	108	103	99	97	95	89	85
Plant H.............	88	92	95	106	119	114	107	102	101	96	90	90
Plant I.............	107	107	105	112	110	103	88	72	66	103	110	112
Plant K.............	92	102	106	111	114	108	106	101	92	87	89	91
Plant L.............	85	90	93	104	114	115	118	107	99	94	93	90
Plant M.............	93	100	99	105	106	105	107	105	95	88	98	102
Oklahoma City.......	94	99	102	108	114	109	107	99	94	92	91	91
Tulsa...............	91	94	96	108	120	113	105	100	98	95	90	88
Total market......	92	97	99	108	117	111	106	100	96	93	91	90

The 4 months of March, May, September, and December 1962 illustrate the daily flow of milk. These months, with the various holidays, provide a basis for observing practices used by marketing firms to minimize the problems resulting from fluctuation in receipts and needs.

The daily average was computed for the overall 4-month period (123-day average) for each of seven representative plants and for these seven plants combined. Scheduled producer receipts for each plant day were then expressed as a percentage of this daily average. Table 2 illustrates the disparity in daily receipts by listing the number of days in certain months that producer receipts were a given percentage of average.

Plant A is a relatively small plant. The grouping of scheduled receipts above and below the daily average emphasizes the fluctuation caused by every-other-day pickup from each patron. This was a case of alternate high and low volume. It is usually impractical for small plants to maintain a uniform bulk collection system, as one load exerts considerable influence. The smaller the plant volume, the more pronounced this fluctuation. It becomes more economical to collect the milk on the most efficient schedule and to store the raw milk in large tanks at the plant for processing on the following day.

Although plant B is relatively large, it experienced much the same alternating high-low pattern. The geographic distribution of producers supplying this plant was such that collection was more efficient with an alternating pattern. The differences were more pronounced during the low production season than in the spring flush. The carryover from peak days amounted to several thousand pounds.

Although receipts at the remaining plants did alternate through high-low patterns from every-other-day pickup, this was overshadowed by a more or less random fluctuation. Such random fluctuations result from weather conditions, road conditions, equipment difficulties, changes in producers, illness, and changes in production. A rather minor variation in any of these factors can cause receipts to fluctuate markedly from day to day. A relatively small increase in total production may make adjustment necessary in the producers served on a given truck run, thereby effecting a new producer and volume realignment.

The data indicate an advantage for large plants, and the even greater advantage realized by a cooperative coordinating the total supply for all plants in a market. The combined producer receipts for the seven plants is significantly more uniform than that of any of the individual plants. Uniting the separate supplies into one total provides benefits by compensating differences in the volume collected for individual plants and by the greater flexibility due to the larger number of trucks involved.

Weekly Producer Receipts

Handlers receiving a full supply from a producers' cooperative normally order their milk for a week at a time. The weekly period is more suitable than the daily period to measure supply fluctuations.

Table 3 compares the weekly fluctuation in producer receipts of each of the seven plants shown in table 2 with the fluctuation of the producer receipts for all seven considered as a single supply. Producer receipts of the individual plants varied more widely than those of the combined supply. Two plants varied less widely than the combined supply; both had slightly increased their supply late in the year, thereby eliminating part of the seasonal decline. It was not possible to adjust the data for these two relatively minor volume increases.

Table 2.--Variation in producer receipts: Number of days that producer receipts by certain plants were a specified percent of the 123-day average--March, May, September, and December 1962

Percent of 123-day average	Plant A	Plant B	Plant C	Plant D	Plant E	Plant F	Plant G	Total for 7 plants
	Number of days							
March 1962								
175								
170-174.9								
165-169.9								
160-164.9								
155-159.9								
150-154.9						1		
145-149.9						0		
140-144.9						0		
135-139.9						0		
130-134.9	6		1			0		
125-129.9	7	1	1		1	0		
120-124.9	1	0	0		0	0		
115-119.9	1	1	2		1	0		
110-114.9	0	9	3		4	8	2	
105-109.9	0	1	4	6	10	14	3	2
100-104.9	0	2	5	5	1	6	6	13
95- 99.9	2	9	3	6	2	2	13	15
90- 94.9	7	3	8	7	5		7	1
85- 89.9	4	2	4	4	4			
80- 84.9	3	1		2	1			
75- 79.9		1		0	0			
70- 74.9		1		1	1			
65- 69.9					0			
60- 64.9					0			
55- 59.9					0			
50- 54.9					0			
- 49.9					1			
0								
May 1962								
175	1							
170-174.9	0							
165-169.9	0							
160-164.9	0							
155-159.9	0				1			
150-154.9	0	1			0	1		
145-149.9	0	0			0	0		
140-144.9	0	0			0	0		
135-139.9	8	0	1		4	2		
130-134.9	2	0	1	2	11	0		
125-129.9	3	0	1	2	1	0	2	
120-124.9	1	1	2	5	1	0	3	2
115-119.9	1	7	5	4	3	2	8	10
110-114.9	0	5	15	7	1	7	12	9
105-109.9	1	4	2	6	1	12	5	9
100-104.9	9	7	2	3	1	4	0	1
95- 99.9	3	4	1	1	1	0	1	
90- 94.9	1	0	0	1	1	0		
85- 89.9	0	0	0		2	1		
80- 84.9	0	0	1		0	0		
75- 79.9	0	0			1	2		
70- 74.9	0	1			1			
65- 69.9	0	0			0			
60- 64.9	0	0			0			
55- 59.9	0	1			0			
50- 54.9	0				1			
- 49.9	1							
0								

Continued

Table 2.--Variation in producer receipts: Number of days that producer receipts by certain plants were a specified percent of the 123-day average--March, May, September, and December 1962--Continued

Percent of 123-day average	Plant A	Plant B	Plant C	Plant D	Plant E	Plant F	Plant G	Total for 7 plants
	Number of days							
September 1962								
175								
170-174.9								
165-169.9								
160-164.9								
155-159.9								
150-154.9								
145-149.9								
140-144.9								
135-139.9		2						
130-134.9		1			1			
125-129.9		0			0			
120-124.9		0			0			
115-119.9		9	1		1			
110-114.9		3	0		3	5		
105-109.9	3	0	4	4	2	4		
100-104.9	8	0	10	7	3	4	16	9
95- 99.9	4	0	2	6	3	8	10	7
90- 94.9	0	0	6	7	5	5	3	12
85- 89.9	0	0	4	4	6	0	1	2
80- 84.9	1	0	3	2	1	0		
75- 79.9	4	4			2	0		
70- 74.9	6	0			2	0		
65- 69.9	4	4			0	2		
60- 64.9		7			1	0		
55- 59.9						0		
50- 54.9						0		
- 49.9						2		
0								
December 1962								
175								
170-174.9								
165-169.9								
160-164.9								
155-159.9								
150-154.9								
145-149.9		1						
140-144.9		0						
135-139.9		0						
130-134.9		0						
125-129.9		4						
120-124.9		5						
115-119.9		2						
110-114.9		2	1		2			
105-114.9	3	2	1	4	0			
100-104.9	8	0	5	9	0	2		
95- 99.9	4	1	6	2	0	5	2	
90- 94.9	0	0	4	2	2	9	5	16
85- 89.9	0	0	1	4	13	7	12	14
80- 84.9	1	1	0	10	4	2	11	1
75- 79.9	4	3	1		4	1	1	
70- 74.9	6	3	11		0	1		
65- 69.9	4	6	0		2	0		
60- 64.9	0	0	1		3	2		
55- 59.9	0	0			0	1		
50- 54.9	0	1			0	0		
- 49.9	0				1	1		
0	1							

Table 3.--Weekly producer receipts of 7 plants (individually and collectively) as a percent of average, March, May, September, and December 1962 1/

	Plant A	Plant B	Plant C	Plant D	Plant E	Plant F	Plant G	7 plants combined	Mean variation 2/
March									
1st week	103	98	96	91	105	105	96	97	4.0
2nd week	113	106	96	93	108	108	97	100	7.9
3rd week	111	95	99	96	106	109	100	102	5.1
4th week	116	104	104	100	98	109	104	104	5.6
Last week	97	103	106	102	90	116	105	103	6.4
Range, high-low	19	11	10	11	18	11	9	7	
May									
1st week	132	109	113	118	124	103	115	115	17.3
2nd week	108	109	116	116	128	107	118	116	14.6
3rd week	123	106	121	113	125	109	115	115	16.0
4th week	113	105	111	114	108	124	110	111	12.1
Last week	115	107	104	108	115	116	110	109	10.7
Range, high-low	24	4	17	10	20	21	8	7	
September									
1st week	88	89	102	99	86	101	97	96	6.3
2nd week	91	95	93	97	100	92	98	96	4.9
3rd week	86	96	98	94	102	92	101	97	5.3
4th week	91	95	96	95	100	97	101	97	3.9
Last week	91	95	96	95	82	97	101	95	6.6
Range, high-low	5	7	9	5	20	9	4	2	
December									
1st week	88	99	83	93	85	91	89	90	8.9
2nd week	91	101	86	94	78	92	86	90	10.6
3rd week	75	102	87	95	90	87	88	91	11.4
4th week	91	86	92	94	91	75	84	89	12.4
Last week	76	97	93	93	79	72	85	88	15.0
Range, high-low	16	16	10	2	13	20	5	3	6.1
Total range	57	23	38	27	50	52	34	28	
Mean variation	13.4	5.4	8.1	7.1	12.1	10.6	8.0	7.4	9.2

1/ Weekly receipts were for 7 consecutive days, beginning with first day of each month. The last week was the last 7 days. There was overlap between 4th and last week in each month. 2/ Mean variation of the 7 individual plants expressed in percentage points departure, plus or minus, from 100 percent.

The coordinated supply varied from 88 percent to 116 percent of average, a range of 28 percentage points. For each 100 pounds of producer receipts at the low point, there were 132 pounds at the peak. This situation emphasizes the fact that plants must procure a larger volume of milk than needed during much of the year to insure adequate supplies during the short season. The greater the volatility of the seasonal production pattern the more reserve the individual plant must carry.

In addition to the difference in relative producer receipt levels by the individual plants, the low points occurred at different times for the separate plants. This offsetting influence would permit additional economies in servicing these seven plants from a single supply. Table 4 combines these two sources of economy by showing the actual weekly volume of producer receipts above the minimum week. The column headed, "7 plants combined," shows the weekly producer receipts volume above the second week in December, the lowest level in the 4-month period (aside from the last 2 weeks in December, which were not used as low points because of the holiday influence). This column, then, shows the reserve that was carried so as to provide producer receipts throughout the period at the level which was available during the second week in December. Although there were only 123 days in the 4-month period, overlapping the fourth and last week in each month permits a 20-week comparison. Based upon 20 weeks, the reserve totaled 12,714,000 pounds, or about 10 percent of total producer receipts.

The column, "Sum of 7 individual plants," summarizes this same comparison for the separate plant supplies. This volume is considerably higher than the combined figure, indicating a greater reserve. The total reserve was 17,542,000 pounds, or about 13 percent of total producer receipts and 29 percent higher than the combined supply reserve for the same plants.

The low point was the first week in March for one plant; the first week in September for one; the first week in December for one; the second week in December for three; and the third week in December for two plants (table 3). These differences would enable a coordinated supply to service the seven plants with a volume equal to each plant's low level with less reserve milk.

The second week in December is the low point in the "Sum of 7 individual plants" column in table 4 (excepting the holiday season). At this level, a combined supply source could provide the seven plants a supply equal to their individual low producer receipt levels with 246,000 pounds less milk than if the plants procured their supplies individually. This amount has been subtrated from the combined weekly supply; results are shown in the column "7 plants combined less 246,000 pounds." The total, 7,794,000 pounds compared with the other two column totals, suggests that all 7 plants could be supplied for 20 weeks from a single supply with 9,448,000 fewer pounds of milk than would be necessary if each plant were responsible for its own supply. Reserves for this fluctuation would be only 44 percent of those needed to supply each plant individually.

These comparisons consider only the weekly fluctuation in producer receipts; inter-relationships between supply and demand are examined later.

Figure 3 compares the relative daily, weekly, and monthly fluctuations in producer receipts for seven bottling plants considered individually and collectively. The entire supply considered collectively exhibits considerably less fluctuation than when it is divided into seven separate parts. The combined daily supply (part A) was between 90 and 109.9 percent of average (plus or minus 10 percent) about two-thirds of the time, while the individual plants were in this range less than one-half the time. The combined supply varied 20 percentage points from average (80 to 119.9 percent of average)

Table 4.--Weekly producer receipts and the volume above minimum level producer receipts of each for 7 plants, March, May, September, and December 1962

	Actual producer receipts: 7 plants 2/	Producer receipt volume above minimum level 1/		
		7 plants combined 3/	Sum of 7 individual plants 4/	7 plants combined, less 246,000 5/
	1,000 pounds	1,000 pounds	1,000 pounds	1,000 pounds
March				
1st week..........	5,985	457	703	211
2nd week..........	6,054	626	862	380
3rd week..........	6,283	755	1,001	509
4th week..........	6,390	862	1,028	616
Last week.........	6,354	826	1,072	580
May				
1st week..........	7,101	1,573	1,819	1,327
2nd week..........	7,131	1,603	1,849	1,357
3rd week..........	7,113	1,585	1,831	1,339
4th week..........	6,850	1,322	1,568	1,076
Last week.........	6,717	1,189	1,435	943
September				
1st week..........	5,918	390	634	144
2nd week..........	5,914	386	632	140
3rd week..........	5,979	451	697	205
4th week..........	5,966	438	684	192
Last week.........	5,849	321	567	75
December				
1st week..........	5,541	13	259	-233
2nd week..........	5,528	0	246	-246
3rd week..........	5,606	78	324	-168
4th week..........	5,468	-60	186	-306
Last week.........	5,427	-101	145	-347
Sum.............	123,274	12,714	17,542	7,794

1/ Volume of producer receipts in excess of the minimum weekly producer receipts (excluding December holidays as low).

2/ Actual producer receipts by the combined 7 plants (1,000 pounds).

3/ Weekly producer receipts in excess of the lowest weekly producer receipts (second week in December) for the 7 plants combined.

4/ Sum of producer receipts by each plant above its own minimum weekly producer receipts.

5/ Column 2 minus 246,000 pounds, the difference for the second week in December between summing the 7 individual plants and combining the 7 as a unit.

only 2 percent of the time, whereas the individuals varied this much 25 percent of the time. Parts B and C show a greater central tendency resulting from longer time periods and from combining the supply.

Until recent years, demand for fluid milk has been described as more stable than the supply from farms. Three major shifts have altered this relationship: (1) Farms have grown larger and more specialized, tending toward more uniform production; (2) shippers to individual plants have been bought together into a common supply for several plants, thereby averaging out some differences in production fluctuations; (3) consumers have shifted from home delivery to purchasing milk in supermarkets, where much of the milk is now purchased over the weekend while grocery shopping.

Four types of fluctuations affect demand for milk and dairy products; each directly affects the processors' derived demand for raw milk. These are: (1) Long-time

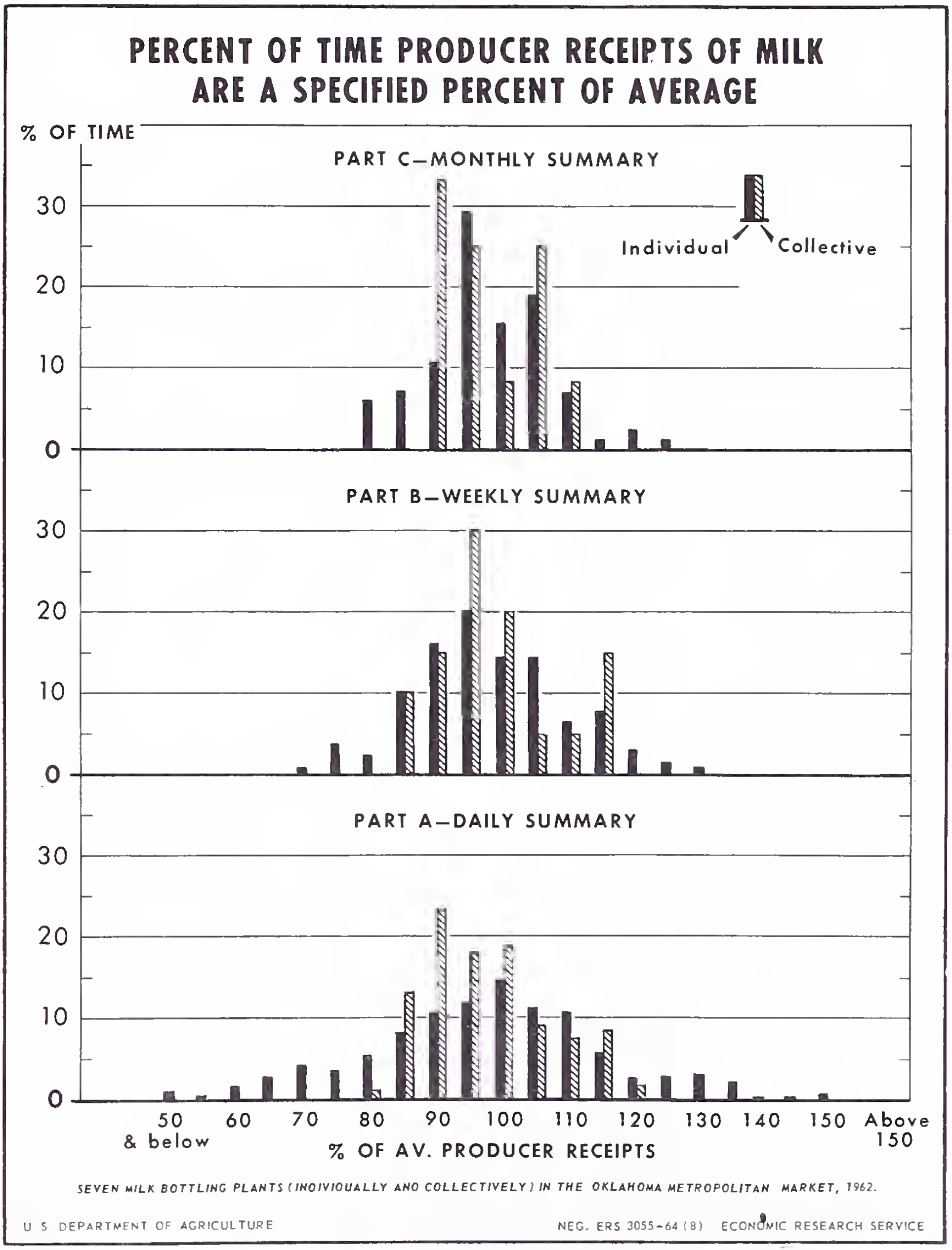
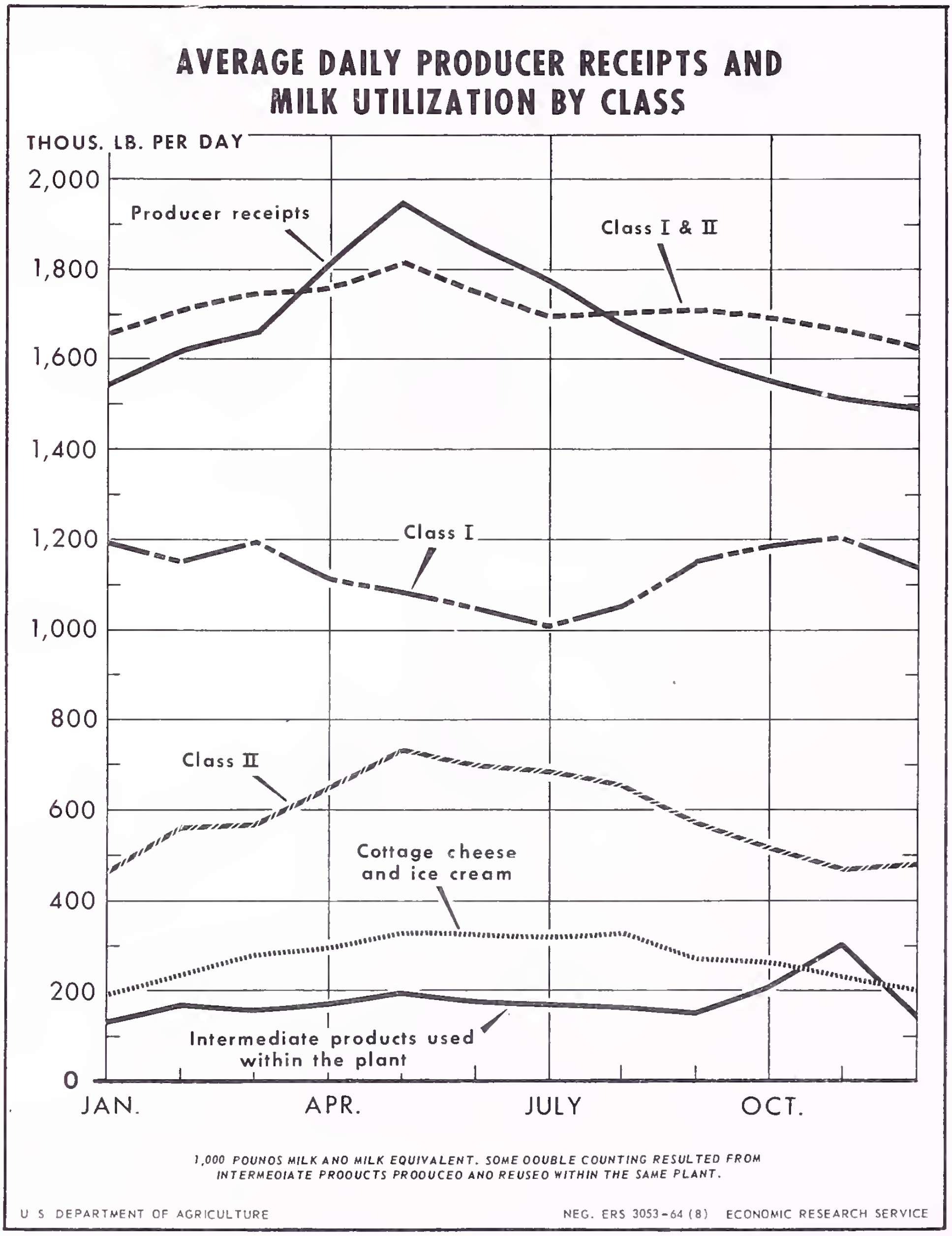


Figure 3

changes in consumer demand; (2) seasonal changes; (3) periodic, within-week variation; and (4) random fluctuations (holidays, weather, etc.). Long-term changes in demand are not within the scope of this investigation.

Seasonal Demand

The seasonal pattern of Class I, or fluid utilization by the plants in the market is shown in table 5 and figure 4. Table 5 compares the seasonal fluctuations of individual plants with those of the groups considered as a unit. The Tulsa group shows the fluctuation in combined fluid use by all plants located in the Tulsa area of the market. The Oklahoma City group includes those plants in the rest of the



1,000 POUNDS MILK AND MILK EQUIVALENT. SOME DOUBLE COUNTING RESULTED FROM INTERMEDIATE PRODUCTS PRODUCED AND REUSED WITHIN THE SAME PLANT.

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Figure 4

Table 5.--Monthly Class I (fluid) use by plants and groups of plants in the Oklahoma Metropolitan Market as a percent of average, 1962

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Sum of points variation
Plant A	105	97	106	101	96	94	92	94	102	104	105	102	57
Plant B	102	100	104	98	100	102	92	91	100	104	106	102	39
Plant C	106	107	110	101	96	90	85	89	101	108	108	99	82
Plant D	102	101	105	97	95	94	87	93	105	103	109	106	63
Plant E	93	101	109	100	91	97	89	97	100	102	107	115	67
Tulsa group	104	101	107	100	96	93	90	92	102	105	107	102	57
Plant F	97	94	98	94	96	99	94	100	102	108	110	108	56
Plant G	108	108	110	104	100	91	88	94	101	100	103	93	68
Plant H	104	101	106	98	96	96	86	92	103	109	107	103	65
Plant I	121	120	116	93	91	85	82	86	100	104	104	98	130
Plant J	105	106	100	95	91	87	78	82	113	116	115	114	136
Plant K	106	99	103	94	92	101	100	101	99	99	109	97	40
Plant L	108	100	104	97	95	94	89	94	104	110	106	100	63
Plant M	109	106	106	102	99	88	84	90	98	107	109	102	82
Plant N	103	103	111	105	105	97	90	92	97	100	99	98	54
Oklahoma City group	106	103	106	98	96	94	89	94	102	105	106	107	58
Market total	105	102	106	99	96	94	89	94	102	105	107	101	54
Mean plant variation:													
Tulsa group	4.5	2.3	6.6	1.4	4.1	5.6	10.4	7.3	1.6	4.3	7.0	5.2	60.3
Oklahoma City group	7.4	5.6	6.3	4.4	5.0	7.2	12.1	7.7	3.1	6.1	7.0	4.5	76.4
Market	6.4	4.4	6.4	3.3	4.7	6.6	11.5	7.6	2.6	5.4	7.0	4.8	70.7

market. The market total combines the Tulsa and Oklahoma City groups. A few very small plants are not shown separately, as they could be identified. The plants omitted contributed very small quantities to the total volume.

Mean plant variation in table 5 refers to the percentage points variation from 100 percent; the sign or direction of variation is ignored. These mean variations for individaul plants show more fluctuation than the same plants do considered as a unit; despite the influence of the very small-volume plants with wide ranges in utilization.

Fluid utilization was highest during fall and winter, tapering off during the spring and reaching a low point in the summer. With minor differences in degree, this same pattern was true for the total market and for each segment. Competitive shifts between plants in the market cause individual volumes to fluctuate without affecting market totals.

The drop in fluid utilization during the summer results from school vacations (including college), vacation from work, hot weather, and substituting soft drinks for milk as a beverage.

Table 6 shows comparative seasonal variation in Class II milk used by plants and groups of plants. Class II use is much heavier during the peak production periods, partly because of greater demand for cottage cheese and ice cream, but mostly because of the heavier milk supply. The effects of the summer drop in Class I utilization are somewhat lessened by the demand for ice cream and cottage cheese; therefore, the total needs are less volatile than either the Class I or II components (fig. 4).

Weekly Demand

Fluctuating weekly utilization is shown in table 7. Three large plants are shown separately, with a combined volume for comparison--the plants are completely independent of each other. Five weeks are shown in each month by overlapping days between the fourth and last week. Utilization for the three plants reached peaks and low points at different times within each month and for the 4-month period. This scattering of relatively heavy and light usage made combined variations less violent than the individual variations. Data from more plants would emphasize this leveling tendency more effectively.

There was a difference of 150,000, 211,000, and 231,000 pounds between the high and the low weekly fluid use of the three plants. The sum of these three individual differences was 592,000 pounds, whereas the difference for the three combined was 364,000 pounds. This was 228,000 pounds less fluctuation, a 39-percent decrease when considering the volume as a collective unit rather than as three separate entities.

Daily Demand

Fluctuations in demand within the week result from heavy consumer purchases during the week-end and from the desire to bottle 5 days per week. This variation depends upon the proportion of milk sold through supermarkets, whether stores are open on Sunday, and the extent to which plants stagger their processing days. The type of supply coordination followed in the market, the degree of plant specialization, and the availability of milk supplies are also factors affecting the utilization pattern at the plant level, although not influencing the consumer demand pattern. The variations within weeks are superimposed upon the seasonal and weekly demand patterns, for both fluid milk and byproducts.

Table 6.--Actual Class II use by specific plants and groups of plants by month as a percent of average, 1962

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Sum of points variation
Plant A	96	86	97	133	121	106	80	83	104	96	99	100	127
Plant B	100	107	93	120	113	87	47	33	107	100	173	127	287
Plant C	61	81	90	106	145	141	132	120	96	84	71	74	287
Plant D	79	105	89	103	110	119	115	128	95	102	76	80	163
Tulsa subtotal	75	85	90	114	132	127	113	110	100	92	80	83	191
Plant E	80	93	91	108	131	123	124	113	93	87	79	77	199
Plant F	64	86	94	109	124	111	130	118	102	99	83	78	190
Plant G	89	100	103	108	102	93	96	97	111	100	92	111	68
Plant H	87	98	93	97	110	104	108	121	116	98	84	86	121
Plant I	60	68	67	102	125	121	114	123	124	96	103	97	224
Plant J	96	98	99	115	97	112	99	100	94	103	98	88	61
Plant K	85	107	108	118	132	118	117	105	81	70	76	82	204
Plant L	75	122	88	92	122	133	141	124	94	77	66	68	282
Plant M	117	138	97	114	128	59	86	93	107	103	93	69	210
Oklahoma City	80	100	97	109	122	116	119	111	95	86	81	83	155
Total market	79	96	95	110	125	119	117	111	97	88	81	83	163
Mean point variation:													
Tulsa group	13	9	6	22	34	39	56	54	13	5	26	33	310
Oklahoma City	20	14	9	10	19	19	17	13	11	9	15	18	174
Total market	18	12	8	14	25	26	31	27	12	7	18	24	222

Table 7.--Comparative weekly utilization variations of 3 individual plants and their combined total volume

	Cottage cheese + ice cream as percent of average				Fluid as percent of average				Fluid + ice cream + cottage cheese as percent of average			
	Plant A	Plant B	Plant C	3 combined	Plant A	Plant B	Plant C	3 combined	Plant A	Plant B	Plant C	3 combined
March												
1st week	98	114	96	103	107	108	121	111	105	108	118	110
2nd week	102	112	109	107	101	106	124	109	101	107	122	109
3rd week	109	117	127	116	103	106	118	108	104	107	120	109
4th week	112	106	118	111	97	107	100	103	100	107	102	104
Last week	91	99	117	100	100	103	90	99	98	102	94	99
Range, high-low	21	18	31	16	10	5	34	12	7	6	28	11
May												
1st week	92	100	108	99	97	104	93	100	96	104	95	100
2nd week	109	134	109	118	90	102	96	98	94	105	98	100
3rd week	114	115	108	113	88	96	91	93	94	98	93	96
4th week	136	85	106	111	109	95	101	99	114	94	101	101
Last week	86	82	108	90	89	86	82	96	89	86	85	95
Range, high-low	50	52	3	28	21	18	19	7	25	19	16	6
September												
1st week	84	90	102	91	92	104	94	98	90	102	95	97
2nd week	117	100	96	106	109	102	108	106	111	102	107	106
3rd week	95	100	99	98	101	103	104	103	100	103	103	102
4th week	115	108	98	108	100	101	104	101	103	101	103	102
Last week	120	106	96	109	99	99	104	100	104	100	103	102
Range, high-low	36	18	6	18	17	5	14	8	21	3	12	9
December												
1st week	99	71	86	86	101	98	105	101	101	96	102	99
2nd week	63	85	90	77	115	95	101	101	106	94	99	98
3rd week	93	88	111	95	119	96	100	104	114	95	101	103
4th week	89	64	77	77	94	85	76	85	93	83	76	84
Last week	84	61	91	78	79	88	81	84	80	85	83	83
Range, high-low	36	27	34	18	40	13	29	20	34	13	26	20
4-month range, high-low	73	73	50	41	40	23	48	27	34	25	46	27

Figure 5 shows the typical within-week fluid sales pattern for three handlers individually and for the three combined. Only actual sales days were considered. Sales volumes were adjusted for 2 days preceding and following national holidays, since these periods represent special problems and should not be confused with the regular within-week patterns. Sales (not quantities bottled) reached the weekly low point on Wednesday and the peak on Friday. These within-week patterns vary between markets, between handlers in a market, and between time periods.

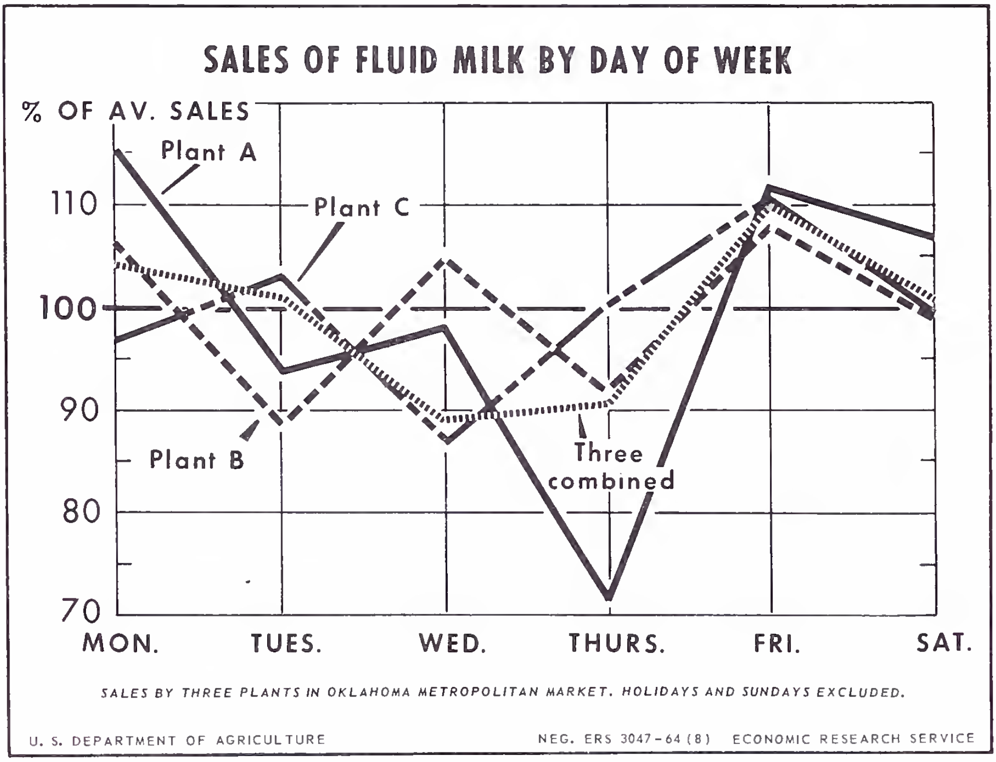


Figure 5

The most erratic fluctuations, those classed as random, are superimposed upon the combined seasonal, weekly, and within-week patterns. This type of variation is relatively unpredictable, both as to timing and intensity. While holidays are certainly predictable in timing, their influence varies considerably, especially as they occur on different days of the week. When a holiday occurs on Monday, shoppers tend to increase weekend purchases. If it is in mid-week, the effect on the preceding day's demand may not be so great.

Table 8 shows the actual daily fluid sales by three plants in March, May, September, and December 1962 as a percent of average sales for the 123 days. All calendar days were counted, although no sales were made on Sunday or on certain holidays. The extreme variability from day to day is the main reason for handlers using the week rather than the day as a balancing period. Although the handlers do not attempt a daily balance, they must still provide facilities that can effectively store, process, and market these variable amounts of milk.

Table 8.--Daily fluid milk sales by 3 plants, individually and collectively, as a percent of average for all calendar days during 4 months (March, May, September, and December 1962)

Date	March				May				September				December			
	Plant A	Plant B	Plant C	3 combined	Plant A	Plant B	Plant C	3 combined	Plant A	Plant B	Plant C	3 combined	Plant A	Plant B	Plant C	3 combined
1	79	140	126	122	110	134	95	119	134	119	98	117	136	115	116	121
2	143	143	165	148	116	76	116	96	0	0	0	0	0	0	0	0
3	121	117	125	120	76	141	104	116	110	121	129	120	163	114	129	130
4	0	0	0	0	131	141	111	131	124	127	104	121	113	119	112	116
5	153	121	159	138	124	119	109	118	127	112	124	118	119	114	125	118
6	105	106	122	109	0	0	0	0	95	125	114	115	88	99	109	99
7	124	128	151	132	124	118	118	120	146	123	87	120	127	130	142	132
8	84	133	119	118	108	121	94	111	136	127	151	135	127	115	125	121
9	139	147	183	154	110	121	132	121	0	0	0	0	0	0	0	0
10	127	113	143	124	72	84	102	85	143	105	136	122	134	97	128	113
11	0	0	0	0	138	125	121	127	124	124	111	121	116	117	114	116
12	134	113	151	127	108	134	102	120	127	99	125	112	119	110	134	118
13	113	113	124	115	0	0	0	0	88	122	115	112	84	102	116	101
14	119	127	151	130	134	134	119	131	143	142	119	137	128	125	88	117
15	81	144	132	126	110	116	88	108	134	112	128	121	131	111	99	113
16	134	125	163	136	108	85	108	96	0	0	0	0	0	0	0	0
17	131	125	116	124	72	108	105	98	146	115	115	123	136	108	108	115
18	0	0	0	0	134	132	116	129	119	134	115	126	110	123	124	120
19	150	113	155	132	113	117	102	112	121	103	118	111	116	97	134	110
20	109	130	118	122	0	0	0	0	83	114	118	107	84	108	102	101
21	113	106	148	117	119	117	115	117	134	144	135	139	135	125	131	129
22	81	145	131	126	105	125	91	112	143	119	121	126	153	129	129	135
23	134	142	145	140	95	74	97	85	0	0	0	0	0	0	0	0
24	132	118	115	121	79	132	97	110	136	112	132	123	167	117	85	122
25	0	0	0	0	127	108	98	110	116	119	107	115	0	0	0	0
26	131	112	122	119	113	107	102	107	119	109	134	117	134	104	116	114
27	113	130	82	115	0	0	0	0	81	95	95	92	79	120	92	103
28	110	102	105	105	124	117	105	116	139	152	138	145	127	124	111	122
29	83	134	94	112	110	150	80	124	123	110	125	116	131	134	111	128
30	134	128	122	128	0	0	0	0	0	0	0	0	0	0	0	0
31	131	115	107	117	150	122	85	120	--	--	--	--	139	132	139	136
Range (omit 0)	74	45	101	49	78	76	52	46	65	57	64	53	88	37	57	37

The smoothing effect achieved by combining individual plant sales into a unit is evident in tables 8 and 9. In general, the central tendency is relatively greater when more plants are considered as a unit, since random and other offsetting influences are more numerous.

The difference between the extreme high and low sales totaled 261,000 pounds for the three individual plants, but only 204,000 for the three collectively, a difference of 28 percent. Expressed as a percent of the maximum daily sales, one plant varied 57 percent, another 51 percent, the third 57 percent, and the three combined varied 45 percent.

CONTRIBUTION TO SURPLUS

Seasonal Surplus

The margin between milk production and fluid consumption fluctuates with changing supply and demand conditions. Figure 6 shows actual daily average producer receipts and Class I utilization by months for 1962. The seasonal pattern was almost identical for the two portions of the market, although Tulsa had more surplus than Oklahoma City.

Seasonally, average total Class I use in the market varied from a low of 1,006,300 pounds per day in July to a high of 1,201,300 pounds in November, a difference of 195,000 pounds, or 16.2 percent.

Producer receipts varied from a daily high of 1,947,000 pounds in May to a low of 1,497,100 pounds in December, a difference of 450,800 pounds or 23.1 percent.

The surplus of producer receipts over Class I utilization ranged from a low of 315,000 pounds per day in November to 864,300 pounds in May. In November this was 26 percent of Class I use; in May, 80 percent. The November surplus was only 36 percent as great as the May surplus.

The 5 months of highest production, April through August, were also the months of lowest Class I utilization. This contraseasonal pattern increases the problem of seasonal surplus and shortage. Figures 7 and 8 show the influences on surplus at different times during the year.

Producer receipts were 199 million pounds greater than Class I use during the year. Fifty-four percent (108 million pounds) of this total was year-round surplus, that margin of low producer receipts above high Class I use. Varying producer receipts accounted for 63 million pounds, or 32 percent of the total surplus. Fluctuating demand for fluid products resulted in over 27 million pounds surplus, nearly 14 percent of the total. The variation in producer receipts was responsible for 70 percent of the excess above year-round surplus, while demand accounted for 30 percent.

Figure 6 shows some differences in the degree to which each component contributed to the total surplus. In the Tulsa portion of the market, variations in producer receipts were more marked than in the Oklahoma City area. Although the peak and the low occurred at the same time in both parts of the market, the Tulsa area had 36 percent greater average daily receipts in May than in December, while the Oklahoma City area receipts were 25 percent higher in May than in December. The combination into a single unit resulted in averaging out, even though the segments were relatively large and the fluctuations coincided as to timing.

Table 9.--Number of days fluid sales by 3 plants were a specified percent of 123-day average during March, May, September, and December 1962

	Percent of average daily fluid sales											
	0	70-79	80-89	90-99	100-199	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189
		Number of days											
March													
Plant A	4	1	4	0	2	5	3	9	1	2			
Plant B	4				3	8	6	4	6				
Plant C	4		1	1	2	4	6	2	3	5	2	0	1
3 combined	4				2	8	9	5	2	1			
May													
Plant A	5	4	0	1	4	8	4	4	0	1			
Plant B	5	2	2	0	3	6	5	5	2	1			
Plant C	5		3	6	9	6	1	1					
3 combined	5		2	3	2	10	7	2					
September													
Plant A	5		3	1	0	4	6	6	5				
Plant B	5			2	3	9	7	1	2	1			
Plant C	5		1	2	2	8	6	5	0	1			
3 combined	5			1	1	9	10	3	1				
December													
Plant A	6	1	3	0	0	6	4	8	0	1	2		
Plant B	6			3	4	9	6	3					
Plant C	6		3	6	8	6	1	1					
3 combined	6		2	3	2	9	7	2					
4 months													
Plant A	20	6	10	2	6	23	17	27	6	4	2		
Plant B	20	2	2	5	13	32	24	13	10	2			
Plant C	20		8	15	21	24	14	9	3	6	2	0	1
3 combined	20		4	7	7	36	33	12	3	1			

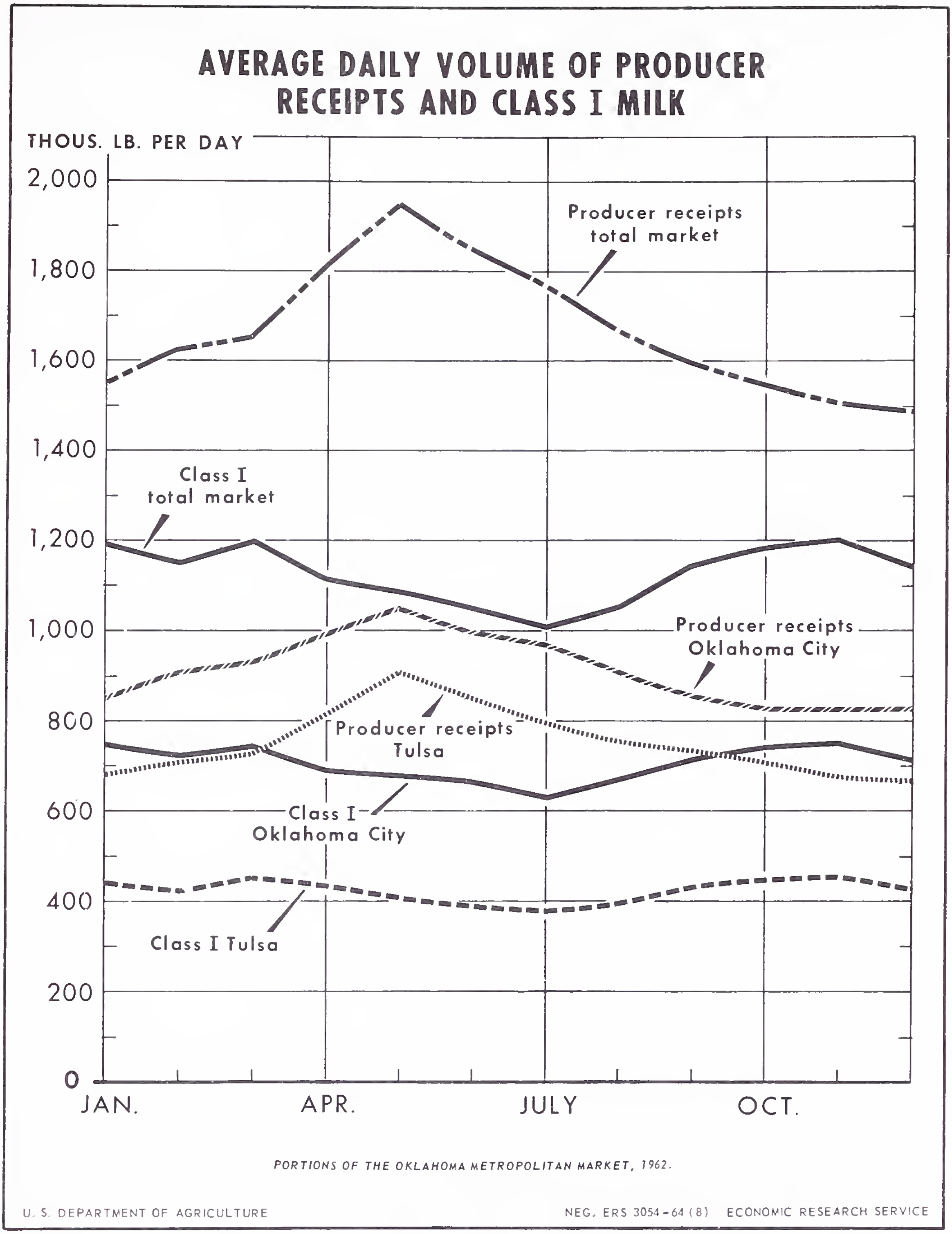

AVERAGE DAILY VOLUME OF PRODUCER RECEIPTS AND CLASS I MILK
THOUS. LB. PER DAY
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
JAN.
APR.
JULY
OCT.
Producer receipts total market
Class I total market
Producer receipts Oklahoma City
Producer receipts Tulsa
Class I Oklahoma City
Class I Tulsa
PORTIONS OF THE OKLAHOMA METROPOLITAN MARKET, 1962.
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 3054-64 (8)
ECONOMIC RESEARCH SERVICE

Figure 6

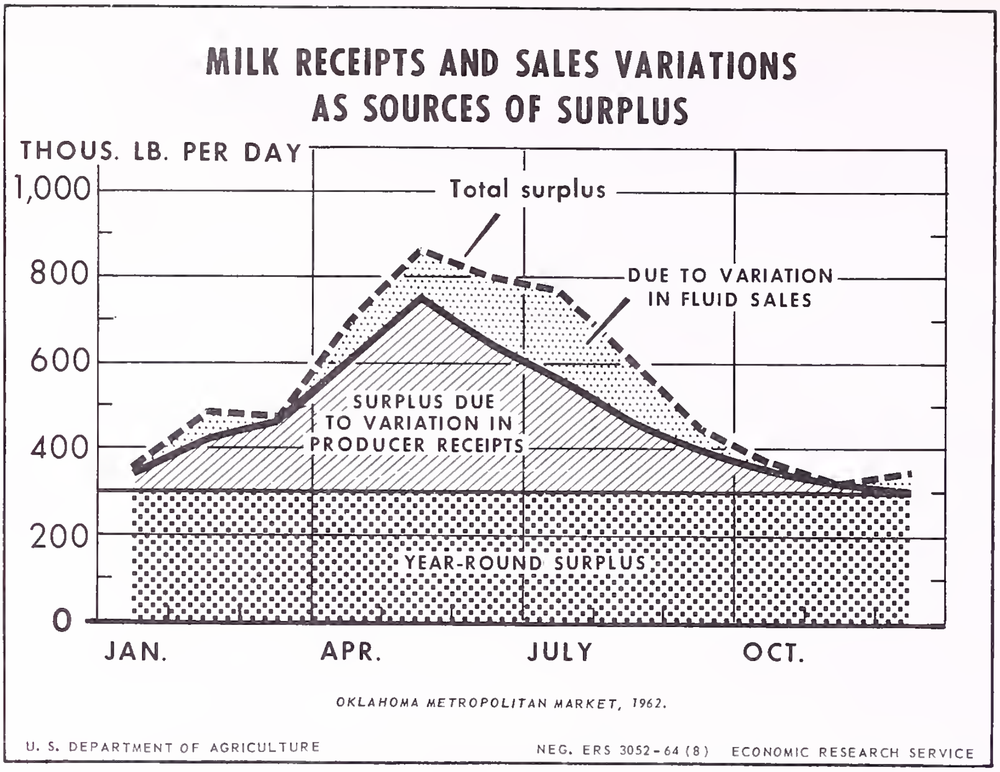


Figure 7

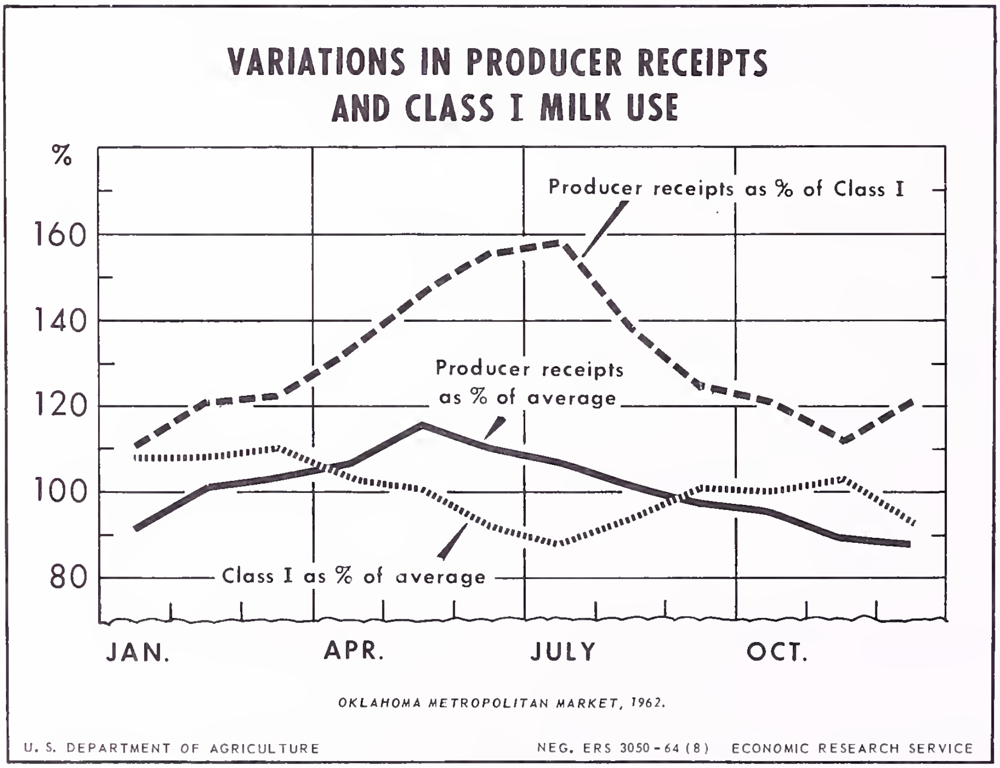


Figure 8

The relative importance of different surplus components was quite variable when comparing individual plants. Gaining or losing a large fluid contract caused wide fluctuation in Class I sales for some handlers. So long as these contracts were serviced by handlers in the market, total Class I utilization by regulated handlers was not affected. This offsetting among plants was more pronounced on the utilization side than for producer receipts. Due to the diverse arrangements for supplies of milk, direct comparisons of the seasonal surplus components were not made for individual plants.

Source of Weekly Surplus

The sources of the weekly surplus at each of three plants and the three combined are shown in table 10. The first column for each plant shows the volume of surplus in that week as a result of the plant selling less fluid milk than it did during the week of peak demand. It is the surplus resulting from variable demand.

Producer receipts also fluctuated from week to week during the 4-month period. The second column shows the quantity by which producer receipts exceeded the lowest week.

These computations show how the fluctuations in producer receipts and fluid use affect the surplus. Year-round surplus is not measured by this method, which may overstate or understate actual total surplus. The relative importance of each fluctuation is indicated by the last line of each column, showing the percentage of the surplus which was due to each fluctuation.

Variations in producer receipts have been discussed in numerous publications. However, most describe fluid demand as uniform, or relatively stable. These comparisons for three handlers combined indicate that approximately 36 percent of the weekly surplus was due to variations in fluid demand, while 64 percent was due to variations in producer receipts. The fluctuating fluid demand contributed 30 percent of the weekly surplus at Plant A, 45 percent at Plant B, and 52 percent at Plant C. Fluctuating producer receipts added 70, 55, and 48 percent.

This 20-week comparison shows 15,062,000 pounds surplus for the three plants separately and 12,233,000 pounds for the three combined. The 2,829,000-pound difference is 23.1 percent of the total for the three combined, indicating that proportionately less reserve would be needed for the combination than for the three separate plants.

These sources of surplus milk should be considered, together with the other patterns of fluctation, when ascertaining the proportion of the supply to carry as reserve milk. Timing is as much a part of the balancing problem as the degree of the variation is.

COORDINATING SUPPLY WITH DEMAND

Seasonal Comparisons

Procurement activities are designed to secure not only a given total volume of milk, but also a supply that enables the firm to meet the fluctuating demand for the products. The difficulty of attaining the desirable balance varies directly with the extent and irregularity of the fluctuations.

Table 10.--Weekly surplus milk at 3 plants arising from fluctuations in fluid use and in producer receipts during March, May September, and December 1962

	Plant A		Plant B		Plant C		Combination of three plants	
	High fluid use minus use for week	Producer receipts for week minus low receipts	High fluid use minus use for week	Producer receipts for week minus low receipts	High fluid use minus use for week	Producer receipts for week minus low receipts	High fluid use minus use for week	Producer receipts for week minus low receipts
	Thous. lbs.	Thous. lbs.	Thous. lbs.	Thous. lbs.	Thous. lbs.	Thous. lbs.	Thous. lbs.	Thous. lbs.
March								
1st week......	0	167	16	172	59	106	0	399
2nd week......	15	161	0	194	87	131	27	440
3rd week......	20	319	30	184	78	142	53	595
4th week......	8	265	120	132	106	140	159	491
Last week.....	51	289	168	78	95	184	229	503
May								
1st week......	39	372	153	295	89	94	226	715
2nd week......	57	411	141	326	141	122	265	813
3rd week......	123	482	166	305	150	138	364	879
4th week......	138	353	117	192	51	240	231	738
Last week.....	231	260	211	240	144	185	311	638
September								
1st week......	44	238	152	52	132	81	253	325
2nd week......	55	131	80	209	47	19	107	313
3rd week......	51	189	100	90	89	16	165	249
4th week......	74	159	102	140	93	49	194	302
Last week.....	89	155	99	133	97	49	210	291
December								
1st week......	98	0	97	45	86	11	206	10
2nd week......	135	28	117	0	19	18	196	0
3rd week......	127	47	122	76	0	0	144	77
4th week......	245	107	237	85	121	0 1/	528	42
Last week.....	215	117	212	7	193	0 1/	545	0 1/
20-week sum.....	1,815	4,250	2,440	2,955	1,877	1,725	4,413	7,820
	Percent of surplus from fluctuation							
	29.9	70.1	45.2	54.8	52.1	47.9	36.1	63.9

1/ Adjusted because of holiday influence.

The plants used different methods of providing balance between demand and supply. The differences between the Tulsa and Oklahoma City portions of the market (fig. 9) illustrate the severity of this problem. One of the three plants depended upon a full supply arrangment. Another planned to meet its fluid needs during the low production season, purchasing extra milk for other uses during this short season and storing some intermediate products during the surplus season. The third plant had organized its procurement so as to meet Class I needs only during the flush production season, depending upon purchases for a balancing mechanism.

Weekly Supply-Demand Balance

Handlers would find it highly impractical, if not impossible, to secure regular receipts so as to achieve a balance between receipts and utilization each day. Even if volumes could be equated, it would be advantageous to employ temporary storage to permit more efficient and timely utilization of facilities. Many handlers feel that under present methods of production, storage, and processing, it is futile to attempt a receipt-utilization balance for periods shorter than a week.

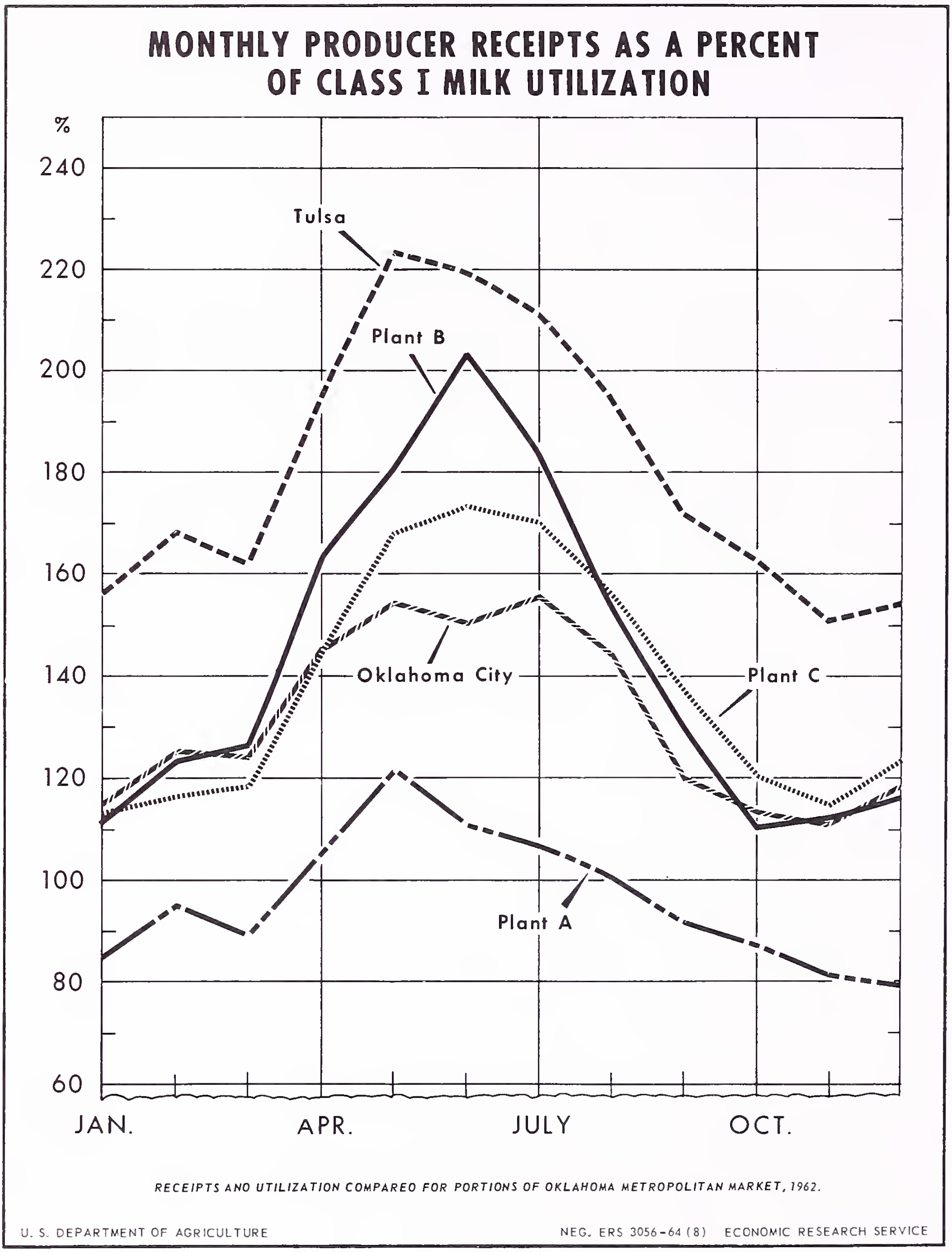
Table 11 compares weekly supply-utilization balancing problems for three representative handlers during the months of March, May, September, and December 1962. The Christmas-New Year period brought a drastic drop in fluid utilization and in deliveries to bottlers. This year-end drop in fluid utilization brought about an increase in the volume of producer milk surplus to fluid needs. Plants did not experience the same difficulty handling this temporary surplus as they did when fluid utilization dropped the last week in May. Total receipts of Grade A milk in the market were approximately 75 percent as great in the latter part of December as in the latter part of May. In addition, the manufacturing plants were receiving less than 60 percent of the May volume from their regular patrons. Both facilities were operating considerably below capacity; therefore, this extra surplus in December caused few physical handling problems.

Diverting a varying proportion of the milk direct to manufacturing plants provided a considerable part of the bottlers' flexibility. The least volatile fluctuation in these comparisons was fluid utilization as a percent of the milk actually received by the plants. The most volatile fluctuation was producer milk as a percentage of fluid utilization. Much, but by no means all, of this fluctuation resulted from contraseasonal patterns of milk production and fluid.

One of the three plants showed a less volatile receipts-use ratio than the three combined, yet the other two were markedly nore volatile. The three combined as a unit were more uniform than the sum of the three separately. The highest weekly ratio was 152 percent of the low ratio for the three plants combined. For the three as individuals, the percentages were 173, 148, and 180, respectively.

Converting these ratios into volume, the common supply would need to provide 1.52 times as much producer milk during the third week of May as during the relatively low production-high consumption period in early December. Considering the supply-utilization for each of these three plants as being independent, the comparable weighted figure would be 1.63, which is a 21 percent higher reserve requirement for the three as individuals than as a common supply-utilization balance.

The critical comparison is the range and variability of the ratio of producer receipts to fluid demand--not the level of the ratio. The violence of change in the ratio gives rise to the major problems encountered by firms seeking to balance supply with demand. These differences result from the interaction of fluctuation in supply and demand. Enlarging the scope to include all handlers in the market would show a less volatile pattern.


MONTHLY PRODUCER RECEIPTS AS A PERCENT OF CLASS I MILK UTILIZATION

RECEIPTS AND UTILIZATION COMPARED FOR PORTIONS OF OKLAHOMA METROPOLITAN MARKET, 1962.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 3056-64 (8) ECONOMIC RESEARCH SERVICE

Figure 9

Table 11.--Comparative weekly variations of 3 individual plants and their combined total volume during March, May, September, and December 1962

Month	Producer milk as percent of average				Producer milk as percent of fluid				Actual receipts as percent of producer milk			
	Plant A	Plant B	Plant C	3 combined	Plant A	Plant B	Plant C	3 combined	Plant A	Plant B	Plant C	3 combined
March												
1st week	104	97	102	100	142	106	114	117	91	100	95	96
2nd week	107	96	105	102	155	107	115	120	91	100	98	97
3rd week	108	109	104	107	154	122	110	128	91	100	101	98
4th week	109	104	96	104	164	116	130	130	86	100	95	95
Last week	115	106	88	104	169	122	132	136	75	100	98	92
Range, high-low	11	13	17	7	27	16	22	19	16	0	6	6
May												
1st week	102	113	120	112	155	128	175	145	73	100	71	85
2nd week	106	116	125	116	173	134	177	153	79	91	69	82
3rd week	108	122	122	118	180	150	182	164	74	89	72	81
4th week	123	111	105	113	166	139	141	146	73	92	73	82
Last week	115	104	112	109	189	142	186	147	72	94	76	83
Range, high-low	21	18	20	9	34	22	45	19	7	11	7	4
September												
1st week	100	102	84	97	160	117	122	128	82	100	90	93
2nd week	92	94	108	97	123	108	135	118	96	100	87	95
3rd week	91	98	90	94	133	113	117	119	97	99	113	102
4th week	96	96	97	96	141	113	127	123	95	100	98	98
Last week	96	96	96	96	142	114	125	123	95	100	91	96
Range, high-low	9	8	24	3	37	9	18	10	15	1	26	9
December												
1st week	90	84	83	85	131	100	107	109	100	100	99	100
2nd week	91	86	76	85	116	107	103	108	104	100	99	101
3rd week	89	87	88	88	109	108	119	109	119	100	113	108
4th week	74	92	89	86	116	128	160	131	113	95	92	98
Last week	71	93	77	83	132	125	129	128	114	100	85	100
Range, high-low	20	9	13	5	23	28	57	23	19	5	28	10
4-month												
Range, high-low	52	38	49	35	80	50	83	56	47	11	44	27

Continued

Table 11.--Comparative weekly variations of 3 individual plants and their combined total volume during March, May, September, and December 1962--Continued

Month	Fluid + ice cream + cottage cheese as percent of actual receipts				Fluid as percent of actual receipts				Fluid as percent of average			
	Plant A	Plant B	Plant C	3 combined	Plant A	Plant B	Plant C	3 combined	Plant A	Plant B	Plant C	3 combined
March												
1st week	95	104	104	102	77	94	93	89	107	108	121	111
2nd week	90	103	101	99	71	93	89	86	101	106	124	109
3rd week	92	92	98	93	71	82	84	80	103	106	118	108
4th week	93	95	96	95	71	86	81	81	97	107	100	103
Last week	98	90	93	93	79	82	77	79	100	103	90	99
Range, high-low	8	14	11	9	8	12	16	10	10	5	34	12
May												
1st week	112	86	95	93	89	78	81	81	97	104	93	100
2nd week	97	93	96	94	73	82	81	80	90	102	96	98
3rd week	102	84	91	90	75	75	76	75	88	96	91	93
4th week	112	85	113	98	83	78	97	83	109	95	101	99
Last week	93	82	86	94	74	74	71	82	89	86	82	96
Range, high-low	19	11	27	8	16	8	26	8	21	18	19	7
September												
1st week	95	93	107	97	76	85	92	84	92	104	94	98
2nd week	110	102	97	102	85	92	85	88	109	102	108	106
3rd week	98	98	87	95	78	89	76	83	101	103	104	103
4th week	98	98	93	97	74	89	81	83	100	101	104	101
Last week	99	97	101	99	74	88	88	84	99	99	104	100
Range, high-low	15	9	20	7	11	7	16	5	17	5	14	8
December												
1st week	97	107	106	104	74	100	94	92	101	98	105	101
2nd week	97	102	112	103	83	94	98	91	115	95	101	101
3rd week	93	102	88	97	77	93	74	84	119	96	100	104
4th week	97	88	80	89	77	82	69	78	94	85	76	85
Last week	86	86	107	90	66	80	91	78	79	88	81	84
Range, high-low	11	21	32	15	17	20	29	14	40	13	29	20
4-month												
Range, high-low	26	21	33	15	23	26	29	17	40	23	48	27

Fluctuation for Individual Plants and Groups of Plants

Figure 10 compares the variation from average fluid sales by three plants considered separately and collectively. Two influences cause the pattern to show a greater central tendency: Increasing the time period and grouping the individual plant volumes.

At some point, a marketing firm will need to adjust operations by either increasing or decreasing inputs, or by reorganizing the input factors. Although this point will vary among markets and among firms, a comparison such as the one shown in figure 10 does provide a guide as to how frequently handlers might expect severe fluctuations. A firm manager would respond much differently if a fluctuation were expected 10 times a year than if the same fluctuation were expected once a week. A manager may determine critical operating levels at which he adjusts the plant operation, procurement, or distribution. He may then use figure 10, or a similar device, to estimate how frequently such variation might be expected. Often it may be more economical to meet infrequent fluctuations with outside facilities.

Figure 11 compares the central tendency of five plants considered individually and combined. Three of the five were those shown in figure 10. Therefore, these two figures emphasize the smoothing effect of grouping a large number of plants. Complete daily data were not available for the two plants; hence figure 11 presents only weekly and monthly comparisons. A greater advantage is gained by combining volatile rather than minor fluctuations.

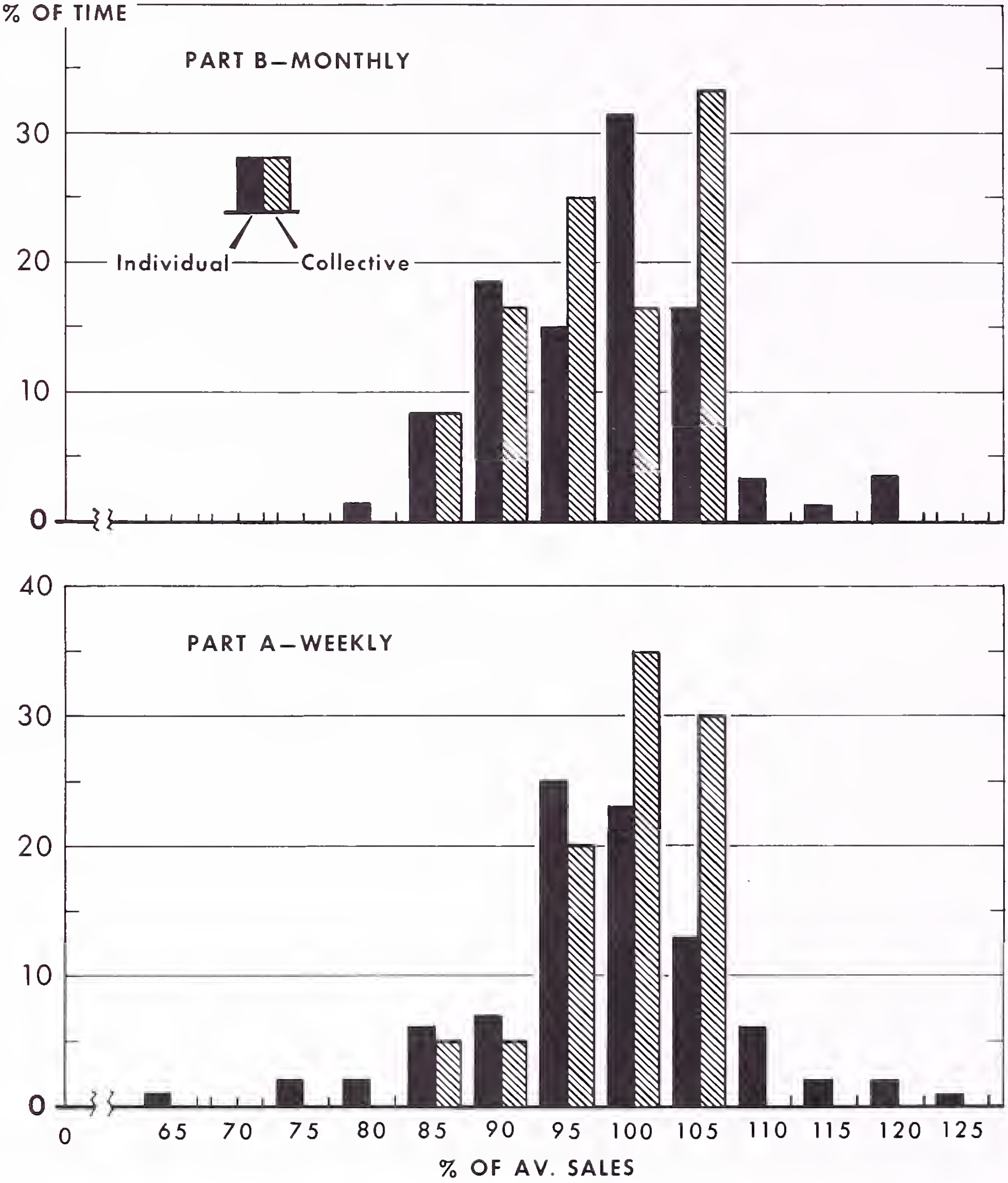
Actual Receipts vs. Scheduled Receipts

A processing plant uses a number of means to adjust receipts. The most common method diverts a portion of the scheduled producer receipts to a manufacturing plant. Plants managing their own procurement and assembly operations and cooperatives serving plants under full supply arrangements use this method regularly. Plants with a full supply arrangement simply indicate the quantity of milk they desire; the cooperative is responsible for any imbalance which may result.

With a full supply arrangement for several plants, a cooperative may service each one from a common supply or assign specific producers to each plant. The former provides a greater degree of flexibility, but requires closer supervision and coordination, since the flow of milk is not automatic. Actual receipts are quantities of milk actually received by the plant, including supplementary supplies; scheduled receipts are quantities of producer milk which would flow to the plant unless diverted. When supplies are adequate, actual receipts are readily tailored to meet the needs of individual plants. Periodic and random fluctuations of supply and assembly may be offset by diverting milk not needed at the plant. The volume of these diversions varies tremendously, as they reflect the full effect of both supply and demand fluctuation.

Table 12 shows the fluctuation in actual receipts of five plants for March, May, September, and December 1962. The actual receipts show more short-time but less seasonal fluctuation than the scheduled producer receipts. The fluctuation is primarily to enhance the handler's ability to serve his market. A large part of this fluctuation is caused by the necessity of building up milk inventory to meet the week-end rush.

Quite probably, the milk actually received by a plant will vary more from day to day in a market with a high degree of reserve milk than in a market where the



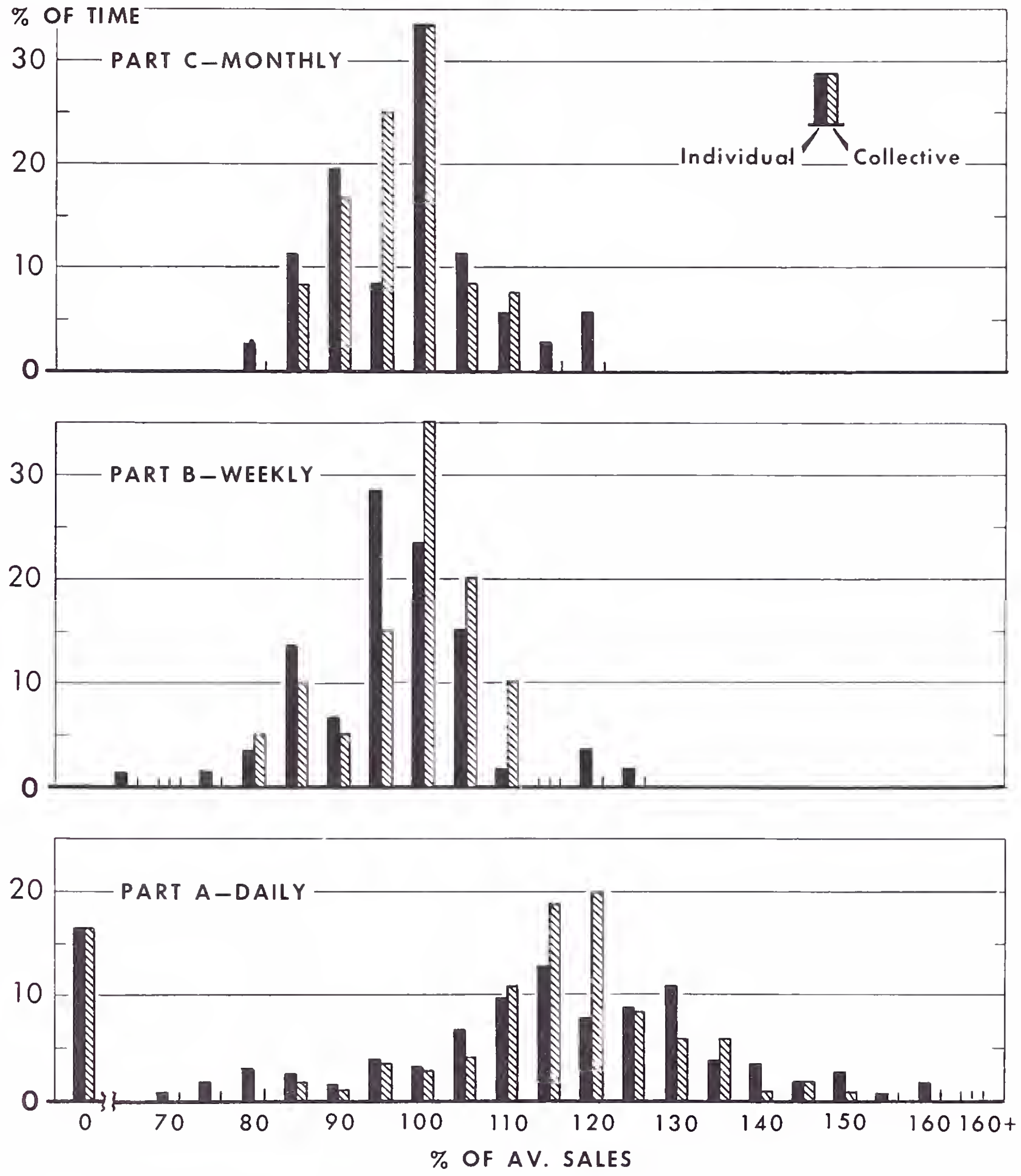
PERCENT OF TIME FLUID MILK SALES ARE A SPECIFIED PERCENT OF AVERAGE

SALES BY FIVE PLANTS (INDIVIDUALLY AND COLLECTIVELY).

U. S. DEPARTMENT OF AGRICULTURE

NEG. ERS 3058-64 (8) ECONOMIC RESEARCH SERVICE

Figure 10



PERCENT OF TIME FLUID MILK SALES ARE A SPECIFIED PERCENT OF AVERAGE

SALES FOR THREE MILK PLANTS (INDIVIDUALLY AND COLLECTIVELY) BY DAY, WEEK, AND MONTH, 1962.

U. S. DEPARTMENT OF AGRICULTURE NEG. ERS 3057-64 (8) ECONOMIC RESEARCH SERVICE

Figure 11

Table 12.--Number of days in which actual receipts by 5 plants were a specified percentage of average in March, May, September, and December 1962 (Adjusted for diversions and supplementary supplies)

Percent of average	Plant A	Plant B	Plant C	Plant D	Plant E	Total of 5 plants combined
	Number of days					
155	1	1			1	
150	3	1			0	
145	0	0		1	1	
140	0	0		0	1	
135	1	1	1	1	3	
130	5	7	0	1	5	
125	13	24	2	1	4	1
120	3	11	3	1	18	0
115	3	11	6	13	8	2
110	8	16	14	13	3	2
105	12	8	16	14	11	21
100	18	5	16	17	10	39
95	9	2	20	19	6	31
90	12	0	17	18	5	23
85	3	5	21	9	8	1
80	8	4	4	2	12	1
75	7	4	2	5	4	0
70	6	2	0	6	8	1
65	0	0	0	0	11	1
60	2	0	1	1	2	
55	3	1		1	0	
50	3	1			2	
Below 50	3	13				
0	0	6				

supply is short. With a long supply, plants can divert or turn back the milk, accepting actual delivery on the very day it best suits their operation. Hence, the pattern of actual receipts will be more volatile than the farm production pattern. In a short market, the plant may find it advisable to take delivery a few days in advance of the actual time desired so as to assure themselves that the milk will be available when needed. These plants may also take delivery of all milk scheduled for them, thereby gradually building up an inventory for the weekend sales rush.

Small plants often accept regular delivery of the milk, then move the surplus portion to a nearby manufacturing plant. This allows them to accumulate a larger volume for shipping than does direct diversion.

When plants find it necessary to bring in supplementary supplies, the daily receipts pattern fluctuates violently, as these extra supplies normally are shipped in large tank trucks. The plant rotates stocks so as to absorb the extra milk without disrupting the processing schedule.

Extra Supplies as a Balancing Device

Actual delivery dates of extra supplies for a given plant may be somewhat misleading. Milk may be stored readily for a 2-day period in large bulk storage tanks.

Managers are willing to accept delivery 1 or 2 days before they actually need the extra quantity in order to assure themselves of this milk. If supplies are unusually short, the plant may rotate stock for 4- or 5-day periods, thus enabling them to achieve a more desirable daily balance between needs and supplies. These extra supplies are receipts in addition to the plant's scheduled receipts. They may originate within the market or from another market. Extra supplies are most often needed during the short production period.

In a market where most plants operate neither on Sunday nor Wednesday, milk will be more readily available on Saturday, Sunday, and Wednesday than on other days. The daily pattern of extra supplies delivered coincides not so much with the pattern of utilization as with the pattern of available milk supplies. In view of the time lapse between receipt and utilization of the extra supplies, little is revealed by computing the average patterns of such receipts, except an indication of availability of supplies.

The daily receipt pattern of extra supplies by five plants in the Oklahoma Metropolitan Market is indicated in table 13 for the 4 months March, May, September, and December 1962. Forty separate shipments were made on 35 different days during the 123-day period. During the 123-day period, there were 5 days in March, none in May, 17 in September, and 13 in December on which extra supplies were received at these five plants. There were only 3 days in September and 2 in December when any two of the five plants received such shipments on the same day. Again, this may tend to reflect the ease or difficulty of obtaining such supplies.

The relative availability of milk for extra supplies may also be gaged by the quantities shipped to manufacturing plants by the cooperatives. The combined volumes shipped to such plants and that shipped by individual cooperatives followed a very similar daily pattern. Expressed as a percentage of the average day, the relative shipments during the 4 months of March, May, September, and December were:

Day	Percent of Average
Sunday	127
Monday	95
Tuesday	86
Wednesday	110
Thursday	84
Friday	91
Saturday	106

For each 100 pounds of milk shipped to surplus manufacturing plants on Thursday (the low day), there were 152 pounds on Sunday, 112 on Monday, 101 on Tuesday, 124 on Wednesday, 107 on Friday, and 125 on Saturday. With these differences, extra spot shipments were more readily available over the week-end. Since the flow of milk during the Christmas-New Year holidays was highly irregular, that period was not included as a part of the daily pattern.

Diverting Milk to Attain a More Desirable Balance

Plants in the Oklahoma Metropolitan Market received most of their milk from a designated group of producers, either directly or through a cooperative. The hauler delivered this milk to the plant to which these producers were assigned, unless the

Table 13.--Receipts of extra supplies by day of the week by 5 handlers in Oklahoma Metropolitan Market during March, May, September, and December 1962

Day	Extra receipts as percentage of average	Number of days in 4 months with extra receipts
	Percent	Number
Sunday	140.8	8
Monday	124.3	6
Tuesday	40.3	3
Wednesday	124.3	6
Thursday	58.2	2
Friday	56.2	4
Saturday	155.9	6
Total	100.0	35

plant instructed that it be delivered elsewhere. These loads were sent either to the cooperative for further disposition or diverted directly to a manufacturing plant.

During the 4 months, March, May, September, and December 1962, there were 243 diversions by 6 of the plants serving the Oklahoma Metropolitan Market (table 14). These occurred on 98 separate days out of the 123 days in the period. There were diversions every day in March and May; on 22 days in September, and 14 days in December. Most of those in December occurred during the holiday season, when the assembling, processing, distributing, and consuming patterns were disrupted. Sunday was the low day. For each 100 pounds diverted on the average Sunday, 137 pounds were diverted on Monday, 194 on Tuesday, 206 on Wednesday, 180 on Thursday, 171 on Friday, and 158 on Saturday.

Table 14.--Number of days in which diversions by 6 plants represented a specified percentage of the regularly scheduled producer receipts for those plants, Oklahoma Metropolitan Market, 1962

Range in percentage	Number of days in:				
	March	May	September	December	4 months (123 days)
0	0	0	8	17	25
.1-2.5	0	0	1	0	1
2.6-5.0	13	0	13	6	32
5.1-7.5	10	0	2	4	16
7.6-10.0	3	5	3	1	12
10.1-12.5	4	1	2	0	7
12.6-15.0	0	1	1	1	3
15.1-17.5	1	5	0	0	6
17.6-20.0	0	10	0	1	11
20.1-22.5	0	4	0	0	4
22.6-25.0	0	3	0	0	3
25.1-27.5	0	2	0	1	3

The irregularity with which diversions occurred--both in number and the total volume--made handling them more difficult. Table 14 shows part of the fluctuation and the marked seasonal differences.

Offsetting Diversions and Extra Supplies

There was some offsetting between the extra supplies needed by certain plants and diversions by others at the same time. Considering 6 plants, there was a total of 31 such occurrences in 123 days. The number of diversions and supplementary supply receipts by these six plants was:

March, 61 diversions, 3 extra receipts; 3 offsetting;
May, 127 diversions, no extra receipts;
September, 33 diversions, 20 extra receipts; 12 offsetting;
December, 22 diversions, 21 extra receipts; 16 offsetting.

In no instance was the need for extra milk exactly met by diversions. When one firm is responsible for coordinating the supply with the needs of several plants, these fluctuations in supply and demand can be balanced with a minimum of reserve milk. Normally only one or two plants diverted milk on a given day (table 15).

Table 15.--Number of plants diverting milk on any given day during March, May, September, and December 1962: 6 plants in Oklahoma Metropolitan Market

Month	Number of days in which diversions were made by:						
	None	1 plant	2 plants	3 plants	4 plants	5 plants	6 plants
March		11	12	6	2		
May			2	4	16	7	2
September	8	14	5	3			
December	17	9	3	1	1		
4 months	25	34	22	14	19	7	2

Coordinating Intercity Shipments

Production and consumption differences between areas make some transfer of milk necessary. Intercity transfer was not large in the Oklahoma Metropolitan Market, but there were opportunities for reducing the total cost of such movements.

The intercity transfers include all the raw milk shipments into and out of each city in the market from or to another city, whether or not the second city was a part of this market. The regular farm-to-plant milk collection and hauling were not considered. A total of 103,101,000 pounds of milk were shipped between cities in the area in 1962 (table 16). Producer receipts in the Oklahoma Metropolitan Market totaled 609,768,000 pounds for the year.

Two savings in intercity transfer could be effected through central supply coordination: (1) Less milk would need to be moved if cross-hauling were reduced or eliminated and (2) distance could be reduced on the shipments by using a more nearly optimum routing pattern.

Table 16.--Intercity milk shipments to and from cities within the Oklahoma Metropolitan Milk Market by months, 1962

Month	Total shipped	Crosshaul 1/	Crosshaul as percent of total shipped	Actual unit miles 2/	Optimum unit miles 3/	Saving in unit miles 4/	Saving as percent of actual
	1,000 pounds	1,000 pounds	Percent	Number	Number	Number	Percent
Jan.....	6,201	474	7.6	605,177	508,179	96,998	16.0
Feb.....	6,936	904	13.0	616,652	544,052	72,600	11.8
March...	6,832	530	7.8	732,108	637,504	94,604	12.9
April...	10,801	1,490	13.8	1,300,087	1,072,519	227,568	17.5
May.....	17,093	643	3.8	1,689,344	1,533,571	155,773	9.2
June....	14,369	1,694	11.8	1,372,887	1,283,412	89,475	6.5
July....	12,237	2,237	18.3	1,262,738	1,152,095	110,643	8.8
Aug.....	8,687	2,069	23.8	883,370	821,790	61,580	7.0
Sept....	5,240	249	4.8	590,572	545,664	44,908	7.6
Oct.....	5,266	414	7.9	584,918	537,671	47,247	8.1
Nov.....	4,186	233	5.6	457,386	419,983	37,403	8.2
Dec.....	5,253	678	12.9	558,715	509,215	49,500	8.9
Total.	103,101	11,615	11.3	10,653,954	9,565,655	1,088,299	10.2

1/ Milk moving into and out of a city during the same time period.
2/ 1,000 pounds of milk hauled 1 mile.
3/ The minimum unit miles which would have resulted from routing actual shipments by transportation programming models.
4/ The difference between actual and optimum unit miles.

The occurrence of intercity transfer was such that the cross-hauling shown in table 16 could have been reduced approximately 70 percent if all the milk were of the same quality.

Transportation models were programed to obtain the optimum pattern to minimize total unit miles (1,000 pounds moved 1 mile). The cost matrix consisted of highway miles between each city. The gross transfer was not altered in this procedure; movement of milk into and out of each city was treated as a given set of qualifications. The routing was changed, the quantity was not. Actual individual plant transfers were used to compute these potential economies. It would not have been practical to attain this optimum flow pattern at all times. Central coordination should have enabled the market to realize approximately 80 percent of the savings in unit miles shown in table 16 as the difference between actual and optimum flow patterns.

Combining the two sources would have resulted in a net reduction of approximately 15 percent in intercity transfer costs, or about $2,000 per month during 1962.

ROLE OF THE MANUFACTURING PLANT

Fluid milk markets have developed a variety of ways to handle the milk not needed by the regular handlers. In Oklahoma, this excess milk was absorbed by manufacturing plants which processed butter, powder, cream, condensed milk, American cheese, and some specialty products. Fluid handlers purchased considerable quantities of condensed milk, cream, and powder from these manufacturing plants to use for ice cream and cottage cheese. Part of the butter, powder, and cheese was sold commercially; and part was disposed of through the Government price support program.

One producers' cooperative started manufacturing excess milk in the new Tulsa plant just after the spring flush in 1963. The cooperative in Oklahoma City was building facilities at that time. Excluding the third cooperative plant located in Enid, either of these plants would have a greater capacity than was available in the immediate area prior to the plant's construction. The independent manufacturing plants have relied upon excess grade A milk for over 50 percent of their total volume. Probably, these new plants will replace a part of the manufacturing capacity which previously served the market. The volume does not appear adequate to sustain operation of the total available capacity at an economic level.

This study considered the existing outlets and utilization as given. The new plants were not operative during the study period, so the analysis considers the prior arrangements.

Fluid handlers on the Oklahoma Market generally have found it advantageous to process only fluid milk, cottage cheese, ice cream, and certain specialty items, depending upon the manufacturing plants to process the other manufactured items and to provide a safety-valve outlet for the excess milk. Such an arrangement permits the handler to utilize space, facilities, and labor more efficiently and much more uniformly than would be possible if he were processing all the producer milk. This arrangement fosters a greater degree of specialization by bottlers and manufacturers. Economies of scale are more readily realized when a limited number of plants handle the excess milk.

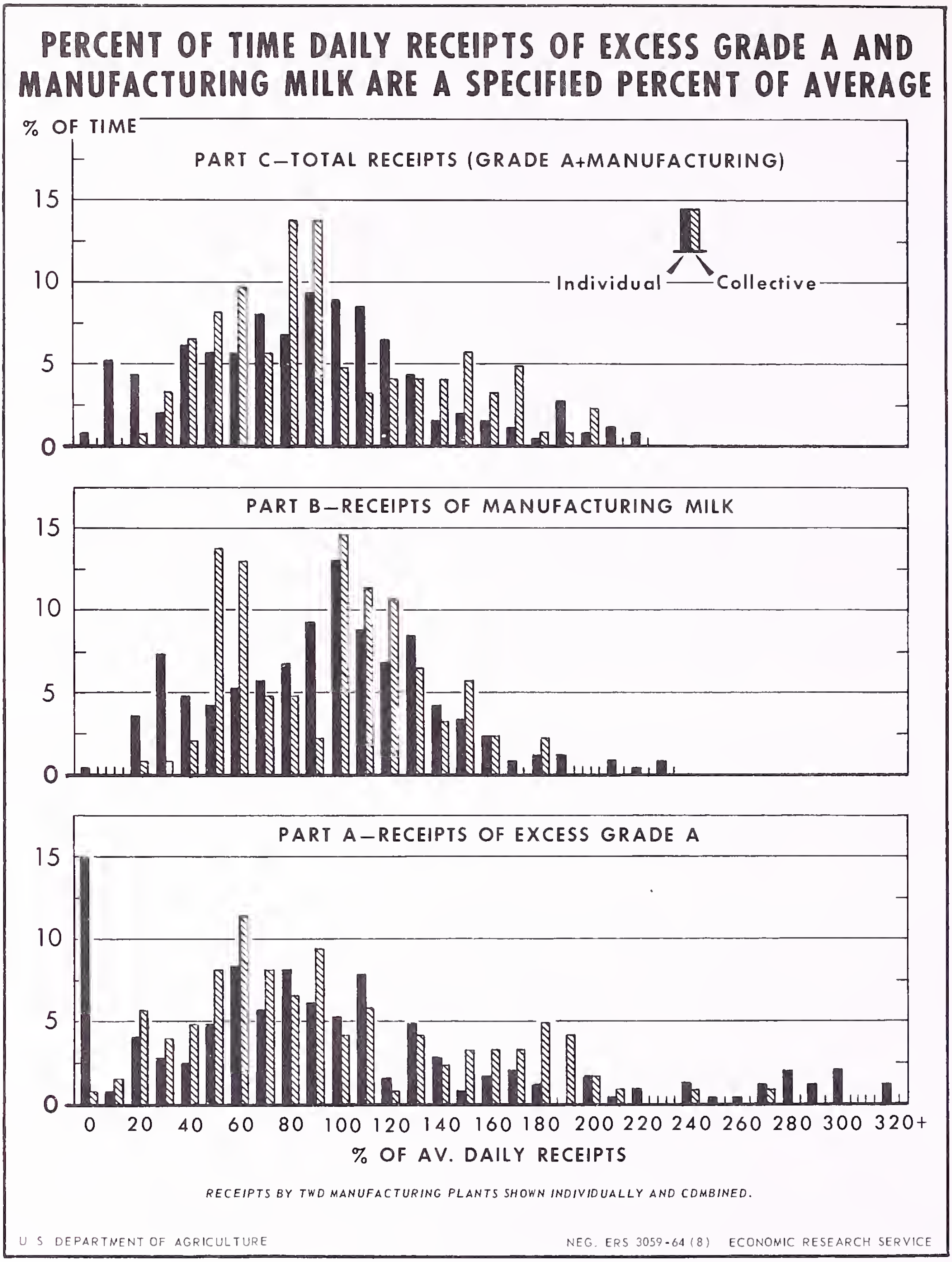
The volume of excess milk (that milk diverted or moved to another plant instead of being processed by the regular handler) is highly variable (fig. 12). Since the manufacturing-grade milk forms a base for operating the plant, the irregular excess milk need not bear the full cost of providing the processing facilities and labor.

Figure 12 compares the degree of fluctuation between manufacturing-grade milk and the grade A excess. Manufacturing-grade milk is generally produced by small herds of cows, showing a highly seasonal pattern. Although grade A milk production is much more uniform, the excess reflects fluctuations in both production and demand. This combination results in pronounced fluctuations, both day-to-day and seasonally. The seasonal pattern follows much the same timing for both grades of milk, further complicating the adjustment these plants must make.

Flexibility is vital to manufacturing plants, because of the extremely variable volume of inputs and the fluctuating demand pattern for the various products. To gain the potential economies of scale in the manufacturing operation, there is a never-ending compromise between the need for flexibility and the need for volume in each product. Absorption of the excess milk is a valuable service to the market. If each handler were forced to process this milk into a variety of products, the total cost of handling the milk supply would be increased severalfold.

Central Compared with Individual Processing of Excess Milk

Managers operating plants basically for fluid bottling and associated products must decide how to handle the excess milk. They may process the milk not needed for their



PERCENT OF TIME DAILY RECEIPTS OF EXCESS GRADE A AND MANUFACTURING MILK ARE A SPECIFIED PERCENT OF AVERAGE

RECEIPTS BY TWO MANUFACTURING PLANTS SHOWN INDIVIDUALLY AND COMBINED.

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Figure 12

fluid, cottage cheese, or ice cream business in their own plants, turn it back to the producers' cooperative, or sell it to a manufacturing plant. Most of the handlers on the Oklahoma Metropolitan Market chose not to process the excess milk in their plants. Four manufacturing plants utilized most of the excess milk. During the spring flush season, milk was moved to eight manufacturing plants not associated with regular handlers.

Table 17 shows the number of days in which six fluid handlers had specified volumes of milk excess to their operations during March, May, September, and December 1962. The cells show the excess volume at each individual plant. The last line under each month combines the excess of the six plants for each day. Table 18 summarizes the relative time that specific volumes of excess milk were available at the individual plants and from the six combined.

Marketing practices are such that it would not be logical to compare local demand with supply for the manufactured products. Therefore, comparisons are limited to relative deviations in the excess milk supply.

Comparative Costs of Handling Excess Milk

The costs of manufacturing excess milk into butter and nonfat dry milk were compared for six plants individually and collectively. Although costs of processing other products would be somewhat different, the unit cost curve for different products does behave similarly.

Model spray-drying plants synthesized by the Idaho Agricultural Experiment Station were utilized to compute the cost of manufacturing. 1/ Model plants of four different capacities were considered. The smallest, Plant I, was designed to operate at a minimum volume of 38,000 pounds of milk daily. Plant II was designed for a minimum of 45,000 pounds; Plant III, 57,000 pounds; and Plant IV, 80,000 pounds per day. The upper volume of operation in a normal operating day was approximately 50 percent above the minimum operating level. Additional volume could readily be processed by working overtime.

The total daily cost for each model plant was computed by multiplying various volumes by the average cost shown in the Idaho analysis (fig. 13). The total cost line for each plant was extended linearly above the normal rated capacity and downward to a minimum of 10,000 pounds of milk in a given day. The fixed daily cost for each model plant was considered applicable for those days when no processing of excess milk was necessary. Although these liberties with the synthesized data might result in slight fallacies in actual cost, it was felt that the comparative relationships were adequately maintained. It is these relationships which are emphasized in this study.

Figure 14 shows the daily fixed cost and daily total cost line for each of the four model plants. Table 19 summarizes the total cost which could be expected when operating each model plant at the actual volumes available.

The number of days during the 4 months in which each handler had the indicated volume of excess milk (table 17) is shown for each of the handlers in table 19. The

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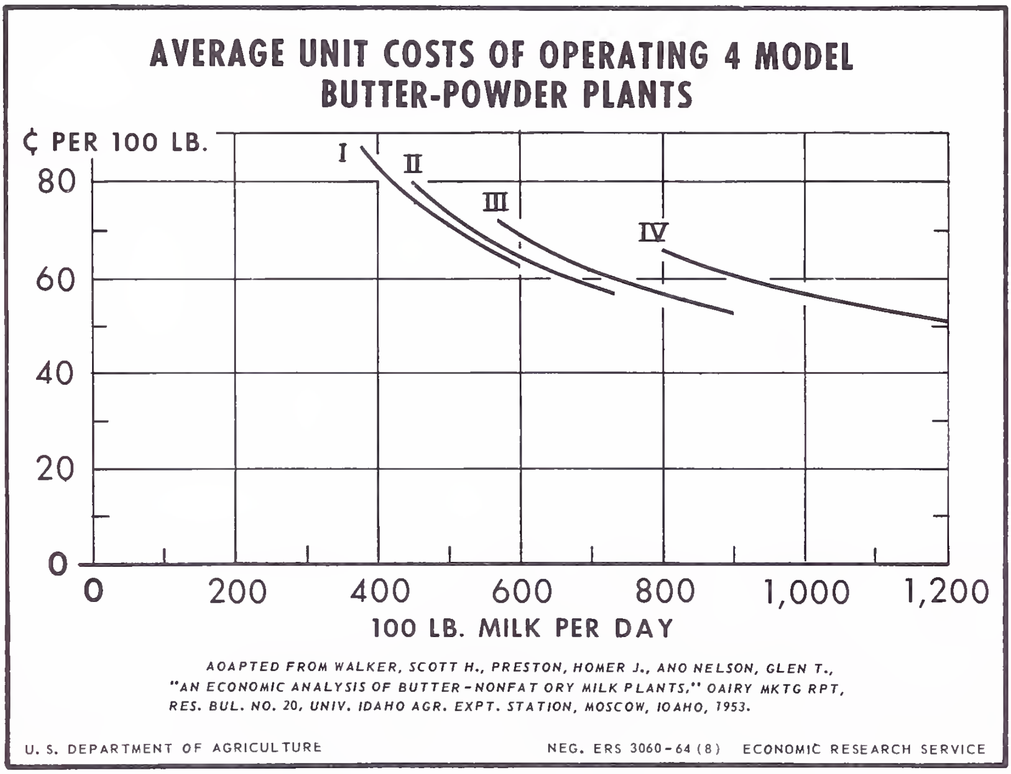
1/ Walker, Scott H., Preston, Homer J., and Nelson, Glen T. An Economic Analysis of Butter-Nonfat Dry Milk Plants. Res. Bul. No. 20, Univ. Idaho, Agr. Expt. Sta. June 1953.

Table 17.--Number of days that 6 fluid handlers had specified volumes of excess milk which was moved to manufacturing plants in March, May, September, and December 1962

Plants	1,000 pounds excess grade A milk used in manufacturing										
	0	1-14	15-29	30-44	45-59	60-74	75-89	90-104	105-119	120-134	135+
	Number of days										
March											
Plant A.....	24		3	3	1						
Plant B.....	31										
Plant C.....	24		5	1	1						
Plant D.....	25		4	2							
Plant E.....	20		10		1						
Plant F.....	1	9	18	3							
6 combined..	0	2	6	14	2	3	1	2	1		
May											
Plant A.....	9	1	8	9	2	0	1	1			
Plant B.....	18	0	5	3	4	1					
Plant C.....	7	1	11	7	5						
Plant D.....	12		6	4	5	3	1				
Plant E.....	6		7	9	5	4					
Plant F.....	6	3	22								
6 combined..	0	0	0	0	1	3	1	2	3	6	15
September											
Plant A.....	22		7	1							
Plant B.....	29	1									
Plant C.....	28		2								
Plant D.....	23		3	2	2						
Plant E.....	15	3	11	1							
Plant F.....	30										
6 combined..	8	1	13	2	3	2	1				
December											
Plant A.....	28			2		1					
Plant B.....	30					1					
Plant C.....	27		3		1						
Plant D.....	26		1	1	3						
Plant E.....	29			2							
Plant F.....	24	2	5								
6 combined..	17	0	6	3	2	0	1			1	1
4-months											
Plant A.....	83	1	18	15	3	1	1	1			
Plant B.....	108	1	5	3	4	2					
Plant C.....	86	1	21	8	7	0					
Plant D.....	86	0	14	9	10	3	1				
Plant E.....	70	3	28	12	6	4					
Plant F.....	61	14	45	3	0	0					
6 combined..	25	3	25	19	8	8	4	4	4	7	16

Table 18.--Number of days in which specified volume of excess milk was available to individual plants and to the 6 combined during March, May, September, and December, 1962

Volume	6 individual plants		Combined total of 6 plants	
1,000 pounds	Number of days	Percent of total days	Number of days	Percent of total days
135+			16	13.0
120-134			7	5.7
105-119			4	3.3
90-104	1	.1	4	3.3
95-89	2	.3	4	3.3
60-74	10	1.4	8	6.5
45-59	30	4.1	8	6.5
30-44	50	6.8	19	15.4
15-29	131	17.7	25	20.3
1-14	20	2.7	3	2.4
0	494	66.9	25	20.3
Total	738	100.0	123	100.0



AVERAGE UNIT COSTS OF OPERATING 4 MODEL BUTTER-POWDER PLANTS

AOAPTED FROM WALKER, SCOTT H., PRESTON, HOMER J., ANO NELSON, GLEN T., "AN ECONOMIC ANALYSIS OF BUTTER-NONFAT ORY MILK PLANTS," OAIRY MKTG RPT, RES. BUL. NO. 20, UNIV. IDAHO AGR. EXPT. STATION, MOSCOW, IOAHO, 1953.

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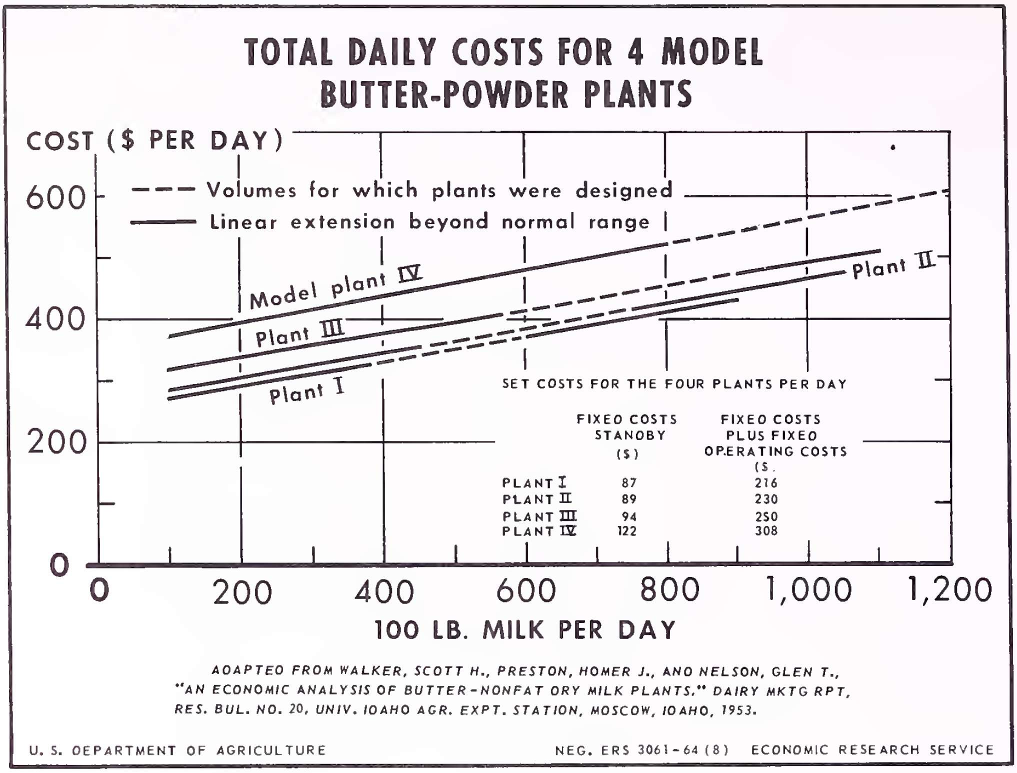
Figure 13



SET COSTS FOR THE FOUR PLANTS PER DAY

	FIXED COSTS STANDBY ($)	FIXED COSTS PLUS FIXED OPERATING COSTS ($)
PLANT I	87	216
PLANT II	89	230
PLANT III	94	250
PLANT IV	122	308

ADAPTED FROM WALKER, SCOTT H., PRESTON, HOMER J., AND NELSON, GLEN T., "AN ECONOMIC ANALYSIS OF BUTTER-NONFAT DRY MILK PLANTS." DAIRY MKTG RPT, RES. BUL. NO. 20, UNIV. IDAHO AGR. EXPT. STATION, MOSCOW, IDAHO, 1953.

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Figure 14

cost of operating each of the four model plants at that volume for 1 day is shown at the top of the table. The cost of processing the milk in each model plant was computed by multiplying the daily cost of operating at the indicated volume by the number of days this volume was available, and summing. These costs are shown as expected if each handler were processing his excess milk in a separate plant and if the excess milk from the six were combined and processed in a single plant.

Managerial problems brought about by violent volume fluctuations are oversimplified by this method. Labor is not fully flexible. Some semblance of a regular crew must be maintained even though not fully utilized. These comparsions tend to understate individual plant operating cost, inasmuch as the labor expenses were charged as though fully flexible.

Despite this relatively favorable treatment, the total cost for six separate plants would have been approximately $118,240 for plants such as model plant I; $123,642 for model plant II; $132,330 for model plant III; $155,242 for model plant IV. The total cost for manufacturing the combined volume in one model plant IV would have been $50,390, considerably less than one-half the minimum cost for six individual plants. Although total costs are shown for all model plants, neither model plants I nor II could have properly processed the available combined excess at all times.

Under certain circumstances, it might be desirable to provide two separate plants for the combined volume. In this instance, two plants the size of model plant II would provide the necessary capacity. The total cost would be approximately $59,124.

Table 19.--Computed costs of operating model butter-powder plants with the volume of excess Grade A milk from 6 bottling plants available for manufacturing purposes during March, May, September, December 1962

Volume 1,000 pounds per day

	Standby	1-14	15-29	30-44	45-59	60-74	75-89	90-104	105-119	120-134	135+	Total 123-days
Cost per day-- model plant:1/												
I..........	$87	$267	$290	$324	$354	$384	$(414)	$(444)	$(474)	$(504)	$(550)	
II..........	89	286	309	338	369	399	429	459	(489)	(519)	(560)	
III..........	94	320	329	373	402	428	458	489	515	542	584	
IV..........	122	370	350	428	460	492	524	556	588	620	670	
Plant A												
No. of days..	83	1	18	15	3	1	1	1				123
Total costs:												
I..........	7,221	267	5,220	4,860	1,062	384	414	444				19,872
II..........	7,387	286	5,562	5,070	1,107	399	429	459				20,699
III..........	7,802	320	5,922	5,595	1,206	428	458	489				22,220
IV..........	10,126	370	6,300	6,420	1,380	492	524	556				26,168
Plant B												
No. of days..	108	1	5	3	4	2						123
Total cost:												
I..........	9,396	267	1,450	972	1,416	768						14,269
II..........	9,612	286	1,545	1,014	1,476	798						14,731
III..........	10,152	320	1,645	1,119	1,608	856						15,700
IV..........	13,176	370	1,750	1,284	1,840	984						19,404
Plant C												
No. of days..	86	1	21	8	7							123
I..........	7,482	267	6,090	2,592	2,478							18,909
II..........	7,654	286	6,489	2,704	2,583							19,716
III..........	8,084	320	6,909	2,984	2,814							21,111
IV..........	10,492	370	7,350	3,424	3,220							24,856
Plant D												
No. of days..	86		14	9	10	3	1					123
Total cost:												
I..........	7,482		4,060	2,916	3,540	1,152	414					19,564
II..........	7,654		4,326	3,042	3,690	1,197	429					20,338
III..........	8,084		4,606	3,357	4,020	1,284	458					21,809

Continued

Table 19.--Computed costs of operating model butter-powder plants with the volume of excess Grade A milk from 6 bottling plants available for manufacturing purposes during March, May, September, December 1962--Continued

	Standby	1-14	15-29	30-44	45-59	60-74	75-89	90-104	105-119	120-134	135+	Total 123 days
IV..........	10,492	0	4,900	3,852	4,600	1,476	524					25,844
Plant E												
No. of days..	70	3	28	12	6	4						123
Total cost:												
I..........	6,090	801	8,120	3,888	2,124	1,536						22,559
II.........	6,230	858	8,652	4,056	2,214	1,596						23,606
III........	6,580	960	9,212	4,476	2,412	1,712						25,352
IV.........	8,540	1,110	9,800	5,136	2,760	1,968						29,314
Plant F												
No. of days..	61	14	45	3								123
Total cost:												
I..........	5,307	3,738	13,050	972								23,067
II.........	5,429	4,004	13,905	1,014								24,352
III........	5,734	4,480	14,805	1,119								26,138
IV.........	7,442	5,180	15,750	1,284								29,656
6 combined												
No. of days..	25	3	25	19	8	8	4	4	4	7	16	123
Total cost:												
I..........	2,175	801	7,250	6,156	2,832	3,072	1,656	1,776	1,896	3,528	8,800	39,942
II.........	2,225	858	7,725	6,422	2,952	3,192	1,716	1,836	1,956	3,633	8,960	41,475
III........	2,350	960	8,225	7,087	3,216	3,424	1,832	1,948	2,060	3,794	9,344	44,240
IV.........	3,050	1,110	8,750	8,132	3,680	3,936	2,096	2,224	2,352	4,340	10,720	50,390
Pl. II + Pl. II:	4,450	1,125	9,950	8,113	3,664	3,904	2,704	2,828	3,072	5,586	13,728	59,124
Sum of 6 individuals												
No. of days..	494	20	131	50	30	10	2	1				738
Total cost:												
I..........	42,978	5,340	37,990	16,200	10,620	3,840	828	444				118,240
II.........	43,966	5,720	40,479	16,900	11,070	3,990	858	459				123,442
III........	46,436	6,400	43,099	18,650	12,060	4,280	916	489				132,330
IV.........	60,268	7,400	45,850	21,400	13,800	4,920	1,048	556				155,242

1/ Adapted from Walker, Scott H., Preston, Homer J., and Nelson, Glen T., "An Economic Analysis of Butter-Nonfat Dry Milk Plants," Western Regional Research Publication, Regional Dairy Mktg. Rpt., No. 20, Univ. Idaho, Agr. Expt. Sta., Moscow, Idaho, 1953.

These six plants were located so that transportation would have added less than $4,000 to the annual cost for the six combined. The saving in transportation due to coordinating the supply for the six plants would more than offset this extra cost.

Expanding the comparison to include the entire market would involve more than twice as many handlers and approximately twice as much excess milk. The relative advantage favoring central responsibility for handling excess milk would be greater for the entire market than for the portion described in table 19. Doubling the above figures would result in a difference of $135,700 in the cost of manufacturing excess milk in the market for 123 days. The yearly difference would be nearly three times this amount, or approximately $400,000.

The advantage of centralized responsibility as compared to individual handler responsibility stems from two sources: Economies of scale and a lesser degree of fluctuation and uncertainty. The contribution of each of these sources would be maximized in the Oklahoma Metropolitan area by considering the entire market as a unit for coordinating the supply.

Centralized responsibility for supply coordination and surplus management could be effectively accomplished if the surplus plant were operated by a regular handler, a producers' cooperative, or a manufacturing milk plant. Certain limitations in the quality of products face plants using a supply of milk not approved for fluid uses.

The geographical division in the Oklahoma Metropolitan Market encourages the tendency to maintain at least a portion of the established supply management and procurement pattern. Traditionally, the market has been considered as the Tulsa side, the Oklahoma City side, and the Enid area. Several subdivisions have existed, but in 1962 these three enveloped the minor divisions. Relatively large capacity for processing excess milk existed in each of the three cities, with additional small plants in each area.

The tables showing probabilities of certain quantities available for manufacturing and the comparative costs indicate that the most economical system would employ a single plant. If the market participants desired to maintain the three major facilities, this could be most economically accomplished under a single coordinating responsibility. Such a system would permit greater efficiency in utilization of facilities and milk.

If a single plant were manufacturing the excess, it would process the combined volume, which was much more regular than the individual volumes. The combination provided a sufficient volume for economical processing more regularly than was available at any of the individual plants.

During the 4-month period there were 123 days, or 738 total days for the six handlers considered. In this period, which represented each production and demand season, the chances were two out of three that the individual plant would have no excess milk. For the combined total, there was only 1 day in 5 with no excess. The individual plants had 30,000 or more pounds only 1 day in 8; the combined volume was this great 57 percent of the time (table 18).

There was some excess milk every day in March and May for the combined total and only 2 days were below 15,000 pounds. In September there were 8 days with no excess scattered throughout the month; none were consecutive. The excess in December was concentrated in 3 days at the first of the month and between the 21st and 30th of the month, with only 1 day in mid-month resulting from a plant experiencing mechanical problems.

Part of the receipts may be stored overnight and processed the following day, or stored for 2 days. By rotating the stocks, a plant can even out the processing operations to a much greater degree than the pattern of receipts. The distribution of receipts on consecutive days was much more suitable for this with the combined total than for any of the individual plants. The one plant which had relatively stable excess had insufficient volume for economical manufacturing.

Combining the excess of the six plants would provide a volume that could be moved to other locations by large tankers. This volume still would not permit economical diversification. Over 60,000 pounds excess was available only three times each in September and December. This points up the problem of fluctuating receipts of those plants utilizing surplus grade A milk and the service performed for the market by these plants.

The excess grade A supplies in the limited and irregular quantities shown for individual plants would not be of much benefit to fluid plants seeking additional supplies. The combination of these supplies by a single firm would provide a much more dependable source, from the standpoint both of regularity and of volume available.

The demand for additional supplies often would utilize the entire supply; on other days, it would decrease the excess appreciably. Even in this market, which was considered fairly well balanced, there were 44 days when at least one of the six plants needed extra supplies during the 4 months in the study. Such needs may be met more adequately from a single source than from a group of uncoordinated individual plants.

CONCLUSIONS

The possibility of improving efficiency by eliminating some of the uncertainty has stimulated many handlers to adopt full supply agreements with a producers' cooperative. Such an arrangement does not eliminate fluctuations, but it does provide a relatively simple, routine means of adjusting supply to demand with minimum effort and expense. The burden of uncertainty is thus borne by a single agency which is in the best position to make the necessary adjustment. The combination of total supply management into this single agency reduces the severity of fluctuations as compared with individualized responsibility.

A producers' cooperative, in addition to being subjected to less intense fluctuation, is able to supply additional needs of one plant with excess supplies which would normally flow to another plant. The cooperative can supply local needs with a smaller reserve than would be feasible when individual handlers manage their own supplies. Inshipments of supplementary supplies may be held down and the necessary shipments more readily secured by a central agency. Excess supplies are effectively routed to manufacturing plants by a central agency.

Handlers employ different means to fill a variable demand for dairy products with a fluctuating supply. Storing milk in large tanks is the most commonly used volume adjustment. Monday's processing may use all of Sunday's receipts and part of Monday's. Tuesday, the carryover plus current receipts will be processed. Wednesday may find the plant closed down except for receiving. These receipts and those arriving early Thursday morning will be utilized on Thursday. The manager will attempt to process all receipts on Friday and Saturday, leaving all tanks empty, with no Sunday processing. The timing may be varied, depending upon the demand pattern, bulk storage, packaged storage, distribution system, and byproducts processed.

Both farm pick-up tanks and large tankers are used for short-time storage. Some plants use school contracts to level out the within-week fluctuation, as they compensate for the week-end rush in supermarkets.

Individual plants can help maintain a favorable balance by varying the processing operations of ice cream, cottage cheese, and other byproducts. Ice cream, especially, offers a leveling device for within-week variations, as it may be emphasized on those days when bottling needs are low.

Handlers also depend upon manufacturing plants for flexibility. Milk not needed by the handler may be moved to the manufacturing plant, which in turn serves as a ready source of the intermediate products. Such products may be processed during those periods when milk receipts are heavy compared with demand and used in final products when demand is greater than receipts. These products are relatively storable and may be shipped from distant markets, so that even a given milk market need not provide its own total flexibility.

Potential Economies from Supply Coordination

Coordinating the milk supply includes procurement, assembly, diversion, handling excess supplies and turnbacks, and providing extra supplies as needed. The transportation and handling of the milk under these various functions are included; bottling, distributing, and manufacturing are not.

The potential benefits to be realized by altering the supply coordination result from alleviating the degree of variability and uncertainty. Benefits might include:

1. Lower reserve requirements,

2. Possible out-of-market shipments,

3. Lower costs of procurement and quality control,

4. Lower collection costs,

5. Lower receiving costs,

6. Lower transportation costs,

7. More effective handling of surplus milk,

8. Improved communication and bargaining between participants.

Reserves Requirements--A fluid milk market has alternative means of providing the milk needed by regular handlers. Traditionally, most markets have sought to adjust procurement activities so that producer milk was just adequate for local needs during the short-supply season. This type of balance meant 11 months with varying quantities of excess milk, quite high at times.

The second most popular method has been to seek a balance between local supply and demand which would provide for all needs except for the month or two of shortest supply. This made inshipments necessary for a few days each year, but on a very limited basis. These needs would be filled by spot shipments from other markets. There would be some excess during the spring flush--perhaps a 4-month period.

Some markets have followed the practice of balancing local supply with demand at a point somewhere below the peak production, but well above the level of either of the other two plans. This plan calls for regular inshipments for perhaps 4 months of the year, spot inshipments for 2 months, with a small excess for 1 or 2 months. This excess might be manufactured into intermediate products by a local handler or be diverted to a plant on the fringe of the market. Usually little or no manufacturing grade milk is produced in this type market.

Each of these general plans is followed in varying degrees by given markets. Each has certain advantages under different circumstances. In time, a market may shift from one plan to another in order to take advantage of changes in technology and cost relationships.

A difference often exists between the producers and handlers as to the most desirable level of supply to maintain. Producers may prefer to limit supply to fluid needs, while handlers usually prefer a supply adequate for fluid milk, ice cream, and cottage cheese.

The percentage of the fluid use carried as reserve needs to be higher than that for combined fluid, cottage cheese, and ice cream utilization, as there is more flexibility in the processing and storing of the last two products, and there are offsetting demand fluctuations.

Markets with a highly seasonal production or demand pattern may need a higher reserve than where these patterns are more uniform. Daily fluctuations are more volatile for milk sold through stores than for home delivery.

An important managerial question becomes, "How nearly should supply and demand be in balance?" A considerably lower reserve would be needed to meet the demand 95 percent of the time than would be needed for 100 percent fulfillment. The reserves carried by a market influence the blend price received by farmers, the products processed in the markets, the method of such processing, the storage facilities for raw milk and products in various stages of processing; and, finally, they influence costs by the effect upon total volume of milk handled and the regularity of this volume.

Out-of-Market Shipment--Those markets which would serve as a source of supplementary supplies for others must have sufficient quantities of milk available at the time desired. There were very few instances in which 40,000 pounds could have been shipped by a single Oklahoma plant, especially during the short season. The chances were increased when the excess milk of the various plants was combined.

Procurement and Quality Control--Fieldmen are used by dairy firms to serve the dual roles of procuring milk and improving the quality of milk produced on the farms. They work directly with dairy farmers in both roles. There is some conflict between fostering public relations for the plant and at the same time enforcing quality regulations. Some managers feel that both these functions can be more effectively performed by a producers' cooperative.

If the cooperative supplies each handler, there need be no really vigorous competitive procurement activity in the milkshed. Proselyting patrons by competing firms would diminish. A decreased number of fieldmen, responsible to one firm, could perform the quality fieldwork with much less travel. There would be no overlapping procurement areas, and the distance between patrons would be reduced proportionately.

The difference can be especially significant in a relatively widespread milkshed with a number of handlers. In the Oklahoma Metropolitan Market, there are probably 14 proprietary handlers and three cooperatives which require some degree of concentrated fieldwork. The overlap and the competition for patronage, if each had responsibility for his own supply, would be staggering. Significant savings are realized by relatively few firms maintaining individual procurement and quality field staffs. Even greater efficiency could be realized if a single agency excercised the entire responsibility.

Collection Cost--The considerations under procurement and quality control are certainly apropos to collection systems. Overlap of areas serviced by competing farm pick-up trucks decreases the effective density of production available to each, thereby raising unit and total truck and labor costs. Costs are lowered when fewer competitive routes serve an area. Fewer routes, with much less travel per unit of milk, can reduce hauling costs and result in higher labor incomes and returns on investment. Plant managers and fieldmen have indicated a positive relationship between hauler income and the quality of service rendered to the patrons on the route.

Flexibility is an essential characteristic for a successful milk collection system. One agency collecting all milk from a given area can easily adjust operations. Procurement competition from other handlers would deny any individual the privilege of adjusting the collection system in order to lower cost. Under such conditions, adjustments are dictated more by efforts to increase individual plant volume than by efficiency of the collection system. Inefficient collection systems with low productivity levels frequently lead to hauler subsidization by the plants. This subsidy and high hauling costs must be absorbed by producers, haulers, plants, or consumers.

Receiving Costs--Savings in this area result from consolidating receiving stations and eliminating some physical handling. The number of receiving or reload stations can often be drastically reduced when a single agency is assembling the milk. This potential is not significant in the Oklahoma market.

Transporation Cost--Reload or receiving stations may provide a less costly means of moving milk from farm to plant than by direct haul in farm pick-up trucks. The saving comes from the decrease in miles driven per unit of milk and in the smaller number of pick-up trucks necessary to service an area. Although the cross-hauling would be eliminated by centralized supply coordination, it is quite probable that over-the-road tanker shipments would increase as this form further replaces long hauls in the small tanks used for farm pick-up. This saving is limited in its application by individual handlers, as large quantities of milk are necessary to achieve it.

Handling Surplus Milk--Handling that portion of the supply considered as "surplus," whether above fluid needs or above total regular plant needs, presents numerous problems. The returns on this milk are considerably lower than for fluid. The quantity available for manufacturing is so variable that it becomes most difficult to provide the proper balance of facilities. Outlets for the products also vary in kind, number, and volume.

These fluctuations are more violent and difficult to meet for individual plants than when one firm provides the manufacturing facilities for the surplus supply. Economies may be gained in the diversion of milk, physical handling, ability to provide flexibility, and ease of meeting demand from the various outlets. Economies of scale are significant in processing plants. Excessive product diversity limits the volume available for any given product.

Communication and Bargaining--A very important consideration in comparing methods of supply management is the ease, rapidity, and probability of making contact with the proper person. When excess milk must be moved, extra supplies are needed in the market, byproducts are needed, or another market needs extra milk, the individuals concerned prefer to contact the person in position to effectuate the desired action. Centralized supply coordination lends itself to this flexibility of action to a greater degree than the individualistic approach. Supply management by competing individual firms complicates the problem of communication between market participants. Centralized management provides ease of communication by decreasing the number of intermediary steps, reducing conflicting interest, and providing specialization of functions.

The manager who is responsibile for coordinating the supply for the market is in a better position to know the relationships within the market and to recognize changes than a person responsible for a limited phase of the supply. By the same token, an error in judgment may go undetected for a longer period with this shift in the traditional checks and balances.

The Individual Handler and Central Supply Coordination

Generally, the more control a firm exercises over the flow of inputs, the greater its opportunity to provide flexibility. There are advantages to a firm from direct contact between producer and processor. What, then, are the inducements which cause an individual handler to accept a full supply agreement and supply coordination by a single firm?

The individual firm may realize substantial gains by relinquishing responsibility for coordinating its milk supply. Quality control may actually be enhanced under central management. The firm can avoid conflict of interest arising from the quest for volume and quality improvement. Milk procurement activities can be decreased or even discontinued and problems associated with directing a fleet of collection trucks and haulers can be bypassed. Patron shifting from one plant to another is stopped. Record keeping and laboratory testing are reduced considerably. Receiving the milk becomes a minor problem, and plant washing and clean-up chores are reduced.

Alleviation of these problems permits building space to be utilized for other needs. Labor coordination may be more readily accomplished and less time lost in transition. Adjustments in volume may be made almost instantly. The plant may exercise real control over its receipts of raw milk, rather than being a victim of fluctuations in production. Sales competition is no longer limited by the effectiveness of the competition on the procurement side.

These advantages are not realized automatically by simply shifting to a full supply arrangement. Management must adapt plant operations to secure these potential benefits. In addition, some offsetting disadvantages may be experienced by individual handlers in turning to full supply and central supply coordination. A firm with a very efficient procurement and assembly operation loses this competitive advantage without gaining a comparable advantage over competitors. The same may be true for those with outstanding quality programs. Some advertising benefit may be lost by firms that now employ a fleet of attractive trucks with plant identification to collect the milk. Certain plants have been in a position to realize profits from timely spot sales on attractive terms.

Individual handlers become more dependent upon the firm responsible for supply coordination. This dependency increases their vulnerability to possible improprieties in supply, collection, and quality programs, and to activities such as milk strikes and labor strikes. This is especially true when centralized supply coordination is associated with hired drivers, rather than the individual contract hauler.

Central supply coordination reduces the direct personal relationship between farmer and processor and may reduce the processor's ability to secure a desired response from individual farmers. The processor could be seriously handicapped by any incompetent or biased management that might develop in the coordinating agency.

Individual firms may also lose the opportunity to benefit from innovations in procurement, collection, assembly, receiving, or in producer relationships. The possibility of the handler exploiting the competitive weakness of another is reduced.

Although some of these relinquishments may not be considered as losses by the industry or by society as a whole, they may represent a sacrifice to an individual handler in his relative competitive situation.

Competition and Fluctuations

Much has been written concerning the ability of different types and sizes of plants to compete effectively in the market place. Many contend that competition is more active when the number of competitors is large and have criticized the full supply contract for reducing competition. There may be less than perfect correlation between numbers of competitors and the effectiveness of competition. Effective competition and efficiency in the marketing processes may require a more appropriate measure than is provided by the number of firms engaged and their corresponding market shares.

Small-volume plants normally experience a greater degree of fluctuation. They must carry an adequate reserve supply to permit them to meet customer needs. This additional reserve imposes inefficiencies in the marketing process and results in lower prices to farmers.

Handlers desiring contracts to supply such institutions as military posts, schools, and hospitals must be in a position to meet the fluctuations brought on by such contracts. These contracts are usually let for a relatively short period of time and must be bid in again. The bidding is normally quite close and a small differential may win or lose a considerable volume of business. A plant serviced under a full supply arrangement need not be concerned about the problems of adding new producers on short notice, dropping producers at the expiration of a contract, or carrying a large overhead of reserve milk. The manager of such a plant is in a position to emphasize physical handling efficiencies and to adapt operations to meet the effective demand, rather than being so vulnerable to shifts in supply and demand.

The shift of a large contract or customer from one handler to another may be quite disrupting in a market where each handler is responsible for his own supply. A market with centralized coordination of the supply would realize little disruptive influence from such a shift so long as the contract remained in the market. Many producers would probably not even become aware of the shift.

This flexibility of the market, resulting from the greater flexibility of the individual participants, permits a more effective competition between handlers. Small firms are able to compete vigorously in bidding for and servicing contracts.

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The market can provide competitive flexibility more economically with central supply coordination than with an independent system. The economy is shown by a lower dollar cost and also by a lower necessary reserve supply. The market needs to provide for this supply only once, whereas each handler would need to provide a goodly portion of the gross needs of any contract he expected to serve--a repetitive provision.